Journal of the Royal Society of Arts

NO. 5057 APRIL 1961 VOL. CIX

FORTHCOMING MEETINGS

THURSDAY, 13TH APRIL, at **5.15 p.m.** COMMONWEALTH SECTION. SIR THOMAS HOLLAND MEMORIAL LECTURE. '*The Commonwealth Association in Theory and Practice*', by J. D. Bruce Miller, M.Ec., Professor of Politics, University of Leicester. K. B. Smellie, Professor of Political Science, London School of Economics and Political Science, in the Chair. (Tea will be served in the Library from 4.30 p.m.)

WEDNESDAY, 19TH APRIL, at **6 p.m.** FERNHURST LECTURE. '*The Nutritional Physiology of Livestock under Natural Conditions*', by K. L. Blaxter, D.Sc., Ph.D., B.Sc.(Agric.), N.D.A., of the Hannah Dairy Research Institute. The Right Honble. Lord Netherthorpe, Past President of the National Farmers' Union, and a Member of Council of the Society, in the Chair.

WEDNESDAY, 26TH APRIL, at **2.30 p.m.** TRUEMAN WOOD LECTURE. '*The Training of Scientists and Engineers for Industry*', by Sir John Cockcroft, O.M., K.C.B., C.B.E., F.R.S., Master of Churchill College, Cambridge. Oswald P. Milne, F.R.I.B.A., J.P., Chairman of Council of the Society, in the Chair.

THURSDAY, 27TH APRIL, at **5.15 p.m.** COMMONWEALTH SECTION. (Joint Meeting with the Royal Commonwealth Society.) '*The Work of the Commonwealth Societies*', by the Right Honble. the Earl De La Warr, P.C., G.B.E., Chairman of the Joint Commonwealth Societies' Conference. Sir Cuthbert Ackroyd, Bt., J.P., Chairman, Victoria League, in the Chair. (Tea will be served in the Library from 4.30 p.m.)

MONDAY, 1ST MAY, at **6 p.m.** The first of three CANTOR LECTURES on '*The Presentation of Science and the Arts on Television*', entitled 'The Presentation of Science', by Tom A. Margerison, Ph.D.

WEDNESDAY, 3RD MAY, at **6 p.m.** '*Technical Advances in Packaging*', by V. G. W. Harrison, Ph.D., Director, Printing, Packaging and Allied Trades Research Association. Milner Gray, R.D.I., PP.S.I.A., a Member of Council of the Society, in the Chair.

MONDAY, 8TH MAY, at **6 p.m.** The second of three CANTOR LECTURES on '*The Presentation of Science and the Arts on Television*', entitled 'The Presentation of the Visual Arts', by Basil Taylor, Hon.A.R.C.A., of the Royal College of Art.

TUESDAY, 9TH MAY, at **5.15 p.m.** COMMONWEALTH SECTION. (Joint Meeting with the Royal India, Pakistan and Ceylon Society, the East India Association, and the Royal Commonwealth Society.) SIR GEORGE BIRDWOOD MEMORIAL LECTURE. '*Rabindranath Tagore*', by Professor George E. Gordon Catlin, M.A., Ph.D. His Grace the Duke of Devonshire, M.C., Parliamentary Under-Secretary of State, Commonwealth Relations Office, in the Chair. (Tea will be served in the Library from 4.30 p.m.) *Special tickets of admission will be required for this meeting. See also Notice below.*

WEDNESDAY, 10TH MAY, at **6 p.m.** '*The Future Pattern of University Education in the United Kingdom*', by J. S. Fulton, M.A., Principal, University College of Sussex.

MONDAY, 15TH MAY, at **6 p.m.** The last of three CANTOR LECTURES on '*The Presentation of Science and the Arts on Television*', entitled 'The Presentation of Music', by Lionel Salter, M.A., Mus.B., L.R.A.M., Head of Music Production, B.B.C. Television.

Fellows are entitled to attend any of the Society's meetings without tickets (except where otherwise stated), and may also bring two guests. When they cannot accompany their guests, Fellows may give them special passes, books of which can be obtained on application to the Secretary.

Official representatives of Companies in association with the Society may also attend, with one guest.

RABINDRANATH TAGORE CENTENARY, 1961

As briefly stated in the March issue of the *Journal* (p. 307), a number of activities to commemorate the centenary of the birth of the Indian poet, author and artist, Rabindranath Tagore (6th May, 1961) have been devised by the Royal Society of Arts, the Royal India, Pakistan and Ceylon Society, the East India Association and the Royal Commonwealth Society, acting in concert. This Society's main contribution to the centenary will be the meeting devoted to the Sir George Birdwood Memorial Lecture on Tagore, which is announced at the head of this page; details of the meetings arranged by the other Societies are as follows:

ROYAL COMMONWEALTH SOCIETY

Thursday, 11th May, 1.15 p.m., at the Society's Headquarters in Northumberland Avenue, W.C.2.

An address on 'Tagore The Man', by Sri Arabinda Basu, Spalding Lecturer in Indian Philosophy, Durham School of Oriental Studies. Professor L. Rushbrook Williams, C.B.E., will preside.

A small Exhibition illustrating Tagore and his writings will be on show in the inner library from 11th to 18th May.

ROYAL INDIA, PAKISTAN AND CEYLON SOCIETY

Friday, 12th May, 6.30 p.m., at Overseas House, St. James's.

An address on 'Tagore As a Musician', by Dr. Arnold Baké, illustrated with gramophone records.

Lilly Freud-Marlé will describe her 'Meetings with Tagore', and give a Recital from his poems.

Sri Arabinda Basu will preside.

EAST INDIA ASSOCIATION

Wednesday, 17th May, 5 p.m., at Overseas House, St. James's.

An address on 'Tagore's Paintings and Drawings', by Dr. Sudhin Ghose, illustrated with lantern slides. The Rt. Honble. Lord Spens, K.B.E., President, East India Association, will preside.

A limited number of complimentary tickets for the three meetings described above will be available to Fellows of this Society on application to the Secretary. Similarly, members of the other named Societies wishing to attend any of these meetings are asked to apply to their own headquarters for tickets.

SECOND ANNUAL RECEPTION

The Second Annual Reception was held at the Society's House on the evening of Friday, 3rd March, when some 250 Fellows of the Society and their guests were received by Mr. Oswald P. Milne, Chairman of Council, and Mrs. Milne. The guest of honour was the President of the Royal Society, Sir Howard Florey, and amongst the other distinguished visitors to the Society's House were the Italian Ambassador, the Lord Mayor of London and the Lady Mayoress, the Mayor and Mayoress of Westminster, the Chairman of the London County Council, Lord Cottesloe, Sir Frederick Handley Page, Mr. W. J. Carron, Mr. Pinin Farina and representatives of a number of other Societies and Institutions.

LUNCHEON IN HONOUR OF PROFESSOR SIMON LISSIM

On Tuesday, 21st February, a luncheon took place at the Biltmore Hotel, New York, in honour of Professor Simon Lissim, the Senior Honorary Corresponding Member in the United States and, since the last Annual General Meeting, a Vice-President of the Society. The function, which was convened and organized by Dr. Earl Frazier, a Benjamin Franklin Fellow, was attended by a company of over ninety, and after a fellow Vice-President, Sir George Edwards, a colleague at City College, New York, Professor d'Andrea, and the Secretary of the Society had spoken of Professor Lissim's qualities as a man, a teacher and a Fellow of the Royal Society of Arts, Dr. Frazier presented a cup as a token of the esteem in which Professor Lissim is regarded by his fellow-Members. In his reply, the Professor expressed the thanks of himself and his wife for the honour which had been done them, and continued:

> On one of those still, cold perhaps somewhat foggy nights when winter is changing into early spring, to be precise on Friday, 22nd March, 1754, at Rawthmell's Coffee House, in old London, two lords, four Fellows of the Royal Society (among them one clergyman), one surgeon, three merchants and an artist—eleven altogether—bent over a table covered with mugs of hot coffee and

piles of papers, and founded a society to be known later as the Royal Society of Arts.

I should like to add, since this gives me special pleasure, that the artist was one William Shipley, a drawing-master from Northampton, a friend of Benjamin Franklin, and the originator of the whole idea: to create a society to encourage young gifted people and to honour the achievements of the older ones. In short, to reward merit. To-day, 207 years later, our Society, one of the oldest learned societies in existence, is continuing the same policies, only on a much broader scale. And it is a comforting thought that being reunited here to-day around a table just as our forebears were on that evening, back in 1754, we are carrying out, in some ways, what was on Benjamin Franklin's mind when in the fall of 1755 he wrote to say that he would like to be admitted as a corresponding member of the Society, and when he affirmed his interest in the Society's activities by agreeing to become the chairman of one of its committees, while residing in London. I believe that we, the Fellows of the Society, are a very special and fortunate group indeed. Our Society is unique, I think, in not restricting itself to a small area of human knowledge. We are not specialized. The arts, science, industry and commerce are all freely represented in our ranks. We are interested in all the fields of human endeavour, and the main reason we are in the Society is to enrich our minds.

By sharing our special knowledge with others, we enrich ourselves and, we hope, better the world around us. In brief, we are or should be in this Society mainly not to get, but to give. And that is why I should so much like this occasion to-day to be the beginning of a new era for our group. Of course, we should expand. Four hundred and forty-four for a growing nation of 180 million is not too large a group. We certainly can double this figure, and do even better in the years to come.

We could also have, in the not too distant future, a 'Benjamin Franklin' wing, or perhaps a less ambitious 'suite' in the beautiful quarters of the Society on John Adam Street, in London.

And there may, of course, be some other projects that will arise from time to time. I wonder whether we shall not all agree that at a time when everywhere there is a strong movement to bring more and more of the humanities into the curriculum of the higher specialized schools (technology to business), it is not the proper time for a society such as ours to reaffirm its desire to encourage the most deserving and gifted of the younger generation in every possible field of human endeavour. Perhaps I feel this way because during the past twenty years this has been one of my immediate concerns and because I see how important such support is in any case to young artists. It must be the same in the field of science without any doubt. I do believe that if we all feel free to call on each other, as important situations arise, we shall be able, perhaps, to account for a few of the 'greats' in the new generations.

VISIT OF THE SECRETARY TO CANADA AND THE U.S.A.

Before attending, at the desire of the Council, the luncheon which was held in New York, on Tuesday, 21st February, in honour of Professor Lissim (see report above), the Secretary made a somewhat extensive, though necessarily hasty, visit to several centres in the United States and Canada, of which a brief report is made here.

He flew to Montreal on Tuesday, 7th February, and his programme in his short visit to that city included two functions organized on behalf of the Society. On 8th February there was an early evening reception given at his delightful home by Mr. Justice Roche and attended by some twenty-five Fellows and their wives, and this was followed on 9th February by a more formal dinner at the Ritz-Carlton Hotel, which was attended by Fellows only, of whom there were about thirty-five present. The dinner was presided over by Monsignor Lussier, Rector of the University of Montreal, and at the conclusion of the meal a paper was read by Dr. Stanford Reid, Professor of History at McGill University, on 'Some Historical Factors in the Development of Canadian Nationalism'. This was the first official gathering of Fellows in Montreal, and the number and standing of the company spoke extremely well for the prospects of the Society in that city.

On 13th February the Secretary attended a cocktail party in Toronto, which was arranged through the kindness of the Honble. G. C. H. Chubb, a Member of Council (who was present at a dinner held in Toronto in 1958 at the time of the Secretary's last visit). Next morning he left for Chicago to be present at the first Royal Society of Arts function held in that city during the present century. This function was arranged by Professor Taylor, the Honorary Corresponding Member for Ohio and adjoining states, and its special purpose was to provide an opportunity for the presentation to Mr. John Chambliss, a Tennessee Fellow, of the Fothergill Medal which was awarded to him last year (see *Journal*, November, 1960, p. 848).

After a brief visit, as Mr. Chambliss's guest, to Tennessee in order to see something of the great T.V.A. Scheme, the Secretary travelled to New York in readiness for the luncheon on 21st February, which is described above. He would like to express the great pleasure which he has again experienced from his association with North American Fellows and his gratitude for the many kindnesses which were shown him.

MEETING OF COUNCIL

A meeting of Council was held on Monday, 13th March. Present: Mr. Oswald P. Milne (in the Chair); Mrs. Mary Adams; Sir Hilary Blood; Lord Bossom; the Honble. G. C. H. Chubb; Mr. R. E. Dangerfield; Mr. Geoffrey de Freitas; Mr. P. A. Le Neve Foster; Mr. E. Maxwell Fry; Mr. John Gloag; Dr. Stanley Gooding; Mr. Milner Gray; Mr. Antony Hopkins; Sir Harry Lindsay; Lord Nathan; Lord Netherthorpe; Mr. Paul Reilly; Sir Gilbert Rennie; Mr. A. R. N. Roberts; Sir Philip Southwell; Professor S. Tolansky; Mr. G. E. Tonge; Mr. C. E. Vignoles; Mr. Hugh A. Warren, and Miss Anna Zinkeisen; with Dr. K. W. Luckhurst (Secretary); Mr. G. E. Mercer (Deputy Secretary), and Mr. J. S. Skidmore (Assistant Secretary).

ELECTIONS

The following candidates were duly elected Fellows of the Society:

Atkin, Alan, St. Annes-on-Sea, Lancashire.
Baker, Mrs. Rose, London.

Biggs, Norman Parris, Weybridge, Surrey.
Boyt, Mrs. Elisabeth, Oxford.
Buxton, Simeon Alan Earp, A.M.I.Mech.E., A.M.I.E.E., Stafford.
Collie, Donald Sivewright, Edgware, Middlesex.
Cox, Cecil Edward John, Chinnor, Oxford.
Croft, Leslie Stuart, Gateshead, Co. Durham.
De Silva, Joseph Joachim Carlo, Dehiwela, Ceylon.
Dooley, Raymond Nelson, M.A., D.Litt., LL.D., Illinois, U.S.A.
Elton, Edward Gustav, South Croydon, Surrey.
Fernandes, Victor Querobino Sebastian, Bombay, India.
Floydd, John David, A.R.I.B.A., Folkestone, Kent.
Forster, Miss Frances Mary, London.
Fuller, Arthur Patrick, London.
Furniss, Martin Dumville, A.R.I.B.A., London.
Gleave, John Geoffrey, B.A., A.R.I.B.A., Timperley, Cheshire.
Hartland, Eric John, A.R.I.B.A., Breconshire, Wales.
Kelly, Richard Giles Talbot, Co. Dublin, Eire.
Kovell, Alfred Joseph, B.A., LL.B., New Jersey, U.S.A.
Macdona, Brian Fraser, London.
Madhavan, R., G.D. Art, Madras, India.
Marshall, Jack, London.
Mendel, Frederick S., Saskatoon, Canada.
Minsos, Alfred Oswald, Dr. Eng., Edmonton, Alberta, Canada.
Moore, Professor John Robert, A.M., Ph.D., Bloomington, Indiana, U.S.A.
Munn, Ronald Percy Valentine, London.
Parker, William, Hale, Cheshire.
Pearse, Derek Sidney, Croydon, Victoria, Australia.
Postma, Dr. Elize Bauduin Jacques, Breukelen, Holland.
Robinson, Godfrey, C.B.E., M.C., North Ferriby, Yorkshire.
Rose, Alex, Stanmore, Middlesex.
Shaw, James Davidson Drewette, M.B.E., Paisley, Scotland.
Sidey, John Wear, London.
Sinclare, Leslie David, London.
Smith, Maurice Russell, Levin, New Zealand.
Williams, Edwin Herbert Horsley, A.R.I.B.A., London.
Winters, Eric Leonard, London.

The following institution was duly admitted into union with the Society:

The Institution of Gas Engineers, London.

The following companies were duly admitted into association with the Society:

Birmid Industries Ltd., Staffordshire.
Dictograph Telephones Ltd., London.
John Brown & Company Ltd., London.

ALBERT MEDAL FOR 1961

Preliminary consideration was given to the award of the Albert Medal for 1961.

R.I.B.A. BOARD OF ARCHITECTURAL EDUCATION

Mr. Sidney Loweth was appointed to represent the Society on the R.I.B.A. Board of Architectural Education, in place of Mr. Hugh A. Warren.

THOMAS GRAY MEMORIAL TRUST COMMITTEE

The resignation of Captain L. G. Garbett from the Chair of the Thomas Gray Memorial Trust Committee was accepted with great regret, and the Council passed a unanimous vote of thanks to him for his work as Chairman of the Committee during the past twelve years.

EXAMINATIONS

It was reported that 57,738 entries had been received for the spring series of examinations, an increase of 3,460 over the corresponding figure for 1960.

ANY OTHER BUSINESS

A quantity of financial and other business was transacted.

INDUSTRIAL ART BURSARIES

1960 COMPETITION

At the request of the Council, the Industrial Art Bursaries Board again organized a competition in 1960. Bursaries, in most cases of £150 each, were offered in 17 different sections. These covered the following subjects: advertising design; carpets; domestic electrical appliances; domestic solid-fuel-burning appliances; dress textiles; electric-light fittings; exhibition display; flat glass decoration; furnishing textiles; furniture; laminated plastics; packaging; pottery; film, stage and television settings; typography; wall-paper, and women's fashion wear. The Sir Frank Warner Memorial Medal was also offered for the best design in the carpet, dress textiles, and furnishing textiles sections.

The competition was open to full-time or part-time students, between the ages of 17 and 30, attending art, architectural, technical or other colleges or schools approved by the Society. In certain sections eligibility was extended to include young draughtsmen, clerks or other similar persons engaged in industry, whether or not they had had any previous art school training, provided that they were recommended by a responsible officer of the industry concerned as having sufficient ability to compete in a national competition. In all, 726 candidates from 81 schools and industrial establishments entered the competition; this compares with 653 candidates in 1959, 495 in 1958, and 423 in 1957, in which years the numbers of schools and industrial establishments represented were 81, 80 and 70 respectively.

Candidates were required both to undergo a set test, carried out under invigilation, and to submit examples of work, chosen from the work done by them in the ordinary course of their studies.

As in the past, the Council's purpose in arranging the competition was to enable successful candidates to enlarge their knowledge and experience by travel abroad and the study of foreign design, or in certain cases to obtain art training or industrial experience in this country. The success of the tours made by Bursary winners depends largely upon their meeting manufacturers and industrial designers in the countries visited, and in past years many people in this country have kindly given assistance by providing helpful introductions. In this connection the Bursaries Board would be grateful to hear from Fellows who may be able to help these students when the latter are abroad.

The Council desires to express its thanks to all those who have assisted and advised in the conduct of the competitions: particularly to the firms, organizations and individuals who generously subscribed towards the cost of the Bursaries, to the Juries for their voluntary services, and to the heads of those organizations entering candidates for their co-operation.

The Council, adopting the recommendations of the Industrial Art Bursaries Board based on the reports of the Juries, has awarded 40 Bursaries, amounting in value to £4,825. The following awards and commendations have been made in connection with the 17 sections included in the competition:

ADVERTISING DESIGN

*Bursaries: John Lenaghan** (Newcastle-upon-Tyne College of Art and Industrial Design: age 17), £225; *Pamela Picknett** (Epsom and Ewell School of Art; age 19) and *Peter Schalkwyk* (Newcastle-upon-Tyne College of Art and Industrial Design: age 21), £175 *each*, and *George Parker* (Salford School of Art and Industrial Design: age 23), £100

Commended: Peter Connor (Salford School of Art and Industrial Design: age 19), *Harold Cullimore* (Leicester College of Art: age 17) and *John Henderson* (Newcastle-upon-Tyne College of Art and Industrial Design: age 22)

CARPETS

Commended: Peter McGowan (John Crossley & Sons Ltd., formerly at the Halifax School of Art: age 26), *Raymond Potter* (Kingston-upon-Thames School of Art: age 25) and *John Preston* (Royal College of Art: age 22)

DOMESTIC ELECTRICAL APPLIANCES

Bursary (£150): *Alan Boyce* (L.C.C. Central School of Arts and Crafts: age 21)

Commended: David Malarkey (Newcastle-upon-Tyne College of Art and Industrial Design: age 20) and *Donald Wright* (L.C.C. Central School of Arts and Crafts: age 25)

DOMESTIC SOLID-FUEL-BURNING APPLIANCES

Bursary (£150): *Michael Crook* (L.C.C. Central School of Arts and Crafts: age 22)

Commended: Neville Green (L.C.C. Central School of Arts and Crafts: age 30), *Colin Grant* (L.C.C. Central School of Arts and Crafts: age 28) and *John Grieves* (L.C.C. Central School of Arts and Crafts: age 20)

DRESS TEXTILES

Bursaries: James Morgan (Royal College of Art: age 24), £250; *Ann Ogle** (Coventry College of Art: age 19), *Margaret Price** (Manchester Regional College of Art: age 18) and *Alena Synac* (Leicester College of Art: age 22), £150 *each*, and *Carolyn Bauer** (Bradford Regional College of Art: age 19), £50

Commended: Deirdre Baker (South-West Essex Technical College and School of Art: age 17) and *Janet Chapman* (Coventry College of Art: age 18)

* Also awarded Associate Membership of the Society.

ELECTRIC-LIGHT FITTINGS

Bursary (£150)*: David Pearson* (L.C.C. Central School of Arts and Crafts, formerly of the Hull Regional College of Art: age 22)

Commended: Eric Symonds (Newcastle-upon-Tyne College of Art and Industrial Design: age 18) and *Alan Willis* (Newcastle-upon-Tyne College of Art and Industrial Design: age 18)

EXHIBITION DISPLAY

Bursary (£150)*: Charles Mynard** (Newcastle-upon-Tyne College of Art and Industrial Design: age 19)

Commended: Pamela Robinson (Cockade Ltd., a part-time student of the L.C.C. Central School of Arts and Crafts, formerly of the Royal College of Art: age 26), *Eric Burdon* (Newcastle-upon-Tyne College of Art and Industrial Design: age 19) and *John Hunt* (Birmingham College of Art and Crafts: age 19)

FILM, STAGE AND TELEVISION SETTINGS

Bursaries: Jane Barchard (B.B.C., formerly of the Wimbledon and Slade Schools of Art: age 24), *Richard Bayldon* (Leicester College of Art: age 22), *Michael Pope** (Wimbledon School of Art: age 19) and *Fred Whitehead* (Royal College of Art: age 23), £150 *each*

Commended: Barbara Farrall (Royal College of Art: age 21), *Tessa Neate* (Wimbledon School of Art: age 19) and *Valerie Shephard* (Wimbledon School of Art: age 22)

FLAT GLASS DECORATION

*Bursaries: David Bartlett** (Kingston-upon-Thames School of Art: age 20) and *Trevor Long** (Kingston-upon-Thames School of Art: age 19), £75 *each*

Commended: Lawson Rudge (Royal College of Art: age 24)

FURNISHING TEXTILES

*Bursaries: Cynthia Bingham** (Thanet School of Art: age 19) and *Tanagra Twomey** (Farnham School of Art: age 19), £125 *each*

Commended: Jeanne-Marie Doyle (Bromley College of Art: age 23), *Louie Moore* (Bradford Regional College of Art: age 24), *Daphne Peters* (West Sussex College of Art and Crafts: age 19), *Pauline Pettet* (Thanet School of Art: age 18) and *Sandra Schofield* (Bradford Regional College of Art: age 20)

FURNITURE

Bursary (£150)*: John Vayro** (Newcastle-upon-Tyne College of Art and Industrial Design: age 19)

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* Also awarded Associate Membership of the Society.

LAMINATED PLASTICS

Bursaries: William James (Royal College of Art: age 22) and *James Wood* (Royal College of Art: age 24), £100 *each*

Commended: Sarah Clarke (Farnham School of Art: age 19), *Irene Brown* (Bromley College of Art: age 20) and *Doreen Ramsdale* (Stockport School of Art: age 17)

PACKAGING

Bursaries: Paul Castell (Royal College of Art: age 23) and *Kenneth Reed** (Newcastle-upon-Tyne College of Art and Industrial Design: age 18), £100 *each*

Commended: Colin Barrett (Newcastle-upon-Tyne College of Art and Industrial Design: age 19), *John Harris* (Hornsey College of Art: age 19), *Kenneth Munslow* (Hornsey College of Art: age 21), *David Palmer* (Twickenham Technical College: age 19) and *Bruce Watters* (Hornsey College of Art: age 20)

POTTERY

Bursary (£150)*: Rosemonde Nairac* (Royal College of Art: age 21)

Commended: Julia Chandler (Royal College of Art: age 22) and *Peter Walton* (Wimbledon School of Art: age 20)

TYPOGRAPHY

Bursaries: Marian Kirsner (L.C.C. Central School of Arts and Crafts: age 22), £125; *Margaret Shillan* (Eyre & Spottiswoode Ltd., formerly at the L.C.C. Central School of Arts and Crafts: age 25), £100; and *David Tudor* (Leicester College of Art: age 24) £75

Commended: Philip Allen (Leicester College of Art: age 22), *Paul Anchell* (Leicester College of Art: age 17), *Leonard Hutton* (Bradford Regional College of Art: age 19), *Peter Sheen* (Leicester College of Art: age 22) and *David Tomlinson* (Coventry College of Art: age 19)

WALLPAPER

Bursary (£150)*: Margaret Shore* (Birmingham College of Art and Crafts: age 21)

Commended: Charles Stevens (L.C.C. Central School of Arts and Crafts: age 22)

WOMEN'S FASHION WEAR

TALFO† *Bursaries: Hilary Floyd** (Royal College of Art: age 20), £150; *June Mackareth** (Newcastle-upon-Tyne College of Art and Industrial Design: age 18) and *Anne Parker* (Birmingham College of Art and Crafts: age 21), £100 *each*

BBSI‡ *Bursary* (£150)*: John Darlow* (Northampton School of Art: age 20)

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* Also awarded Associate Membership of the Society.
† Textiles and London Fashion Organization.
‡ British Boot and Shoe Institute.

Commended: Susan Batt (Edinburgh College of Art: age 19), *Patricia Haynes* (Salford School of Art and Industrial Design: age 18) and *Pamela Swaine* (Leeds College of Art: age 20)

George M. Whiley Bursaries: William James (Royal College of Art: age 22), *James Wood* (Royal College of Art: age 24), *Paul Castell* (Royal College of Art: age 23) and *Kenneth Reed* (Newcastle-upon-Tyne College of Art and Industrial Design: age 18), £37 10*s. each*

The Sir Frank Warner Memorial Medal: James Morgan (Royal College of Art: age 24)

Publication of Report

Full details of the 1960 competition are contained in the annual report which has just been published. This report includes particulars of the tests set in each section, the names of the winning and commended candidates, the reports and composition of the Juries, and a summary of the uses made in 1960 of awards won in previous competitions. Illustrations of many of the 1960 winning designs, a number of which are reproduced on the following pages of this *Journal*, are also included.

Copies of the report can be obtained on application to the Bursaries Officer.

Exhibition

An exhibition of the winning and commended designs submitted in the competition will be held at the Royal Society of Arts during the three weeks preceding Whitsun. The exhibition will be officially opened by Sir John Summerson, C.B.E., F.B.A., F.S.A., A.R.I.B.A., Curator, Sir John Soane Museum, and newly appointed Chairman of the National Council for Awards in Art and Design, on Tuesday, 2nd May, at 3 p.m., and will be open to the public from 4 p.m. on that date until Friday, 19th May.

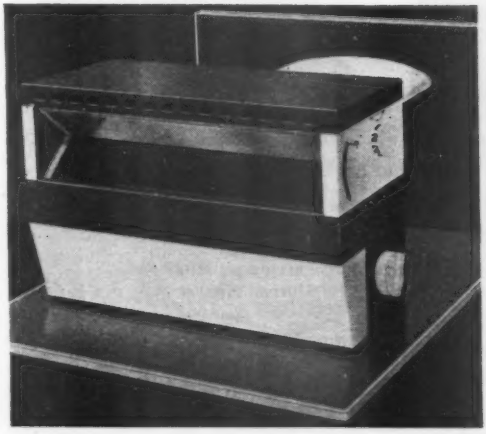
Special cards of admission will be required for the opening, and although it is expected that the majority of these cards must be issued to those who are directly concerned with the organization of the competition, a number will be available for other Fellows. Those Fellows who are interested should apply to the Bursaries Officer.

1961 COMPETITION

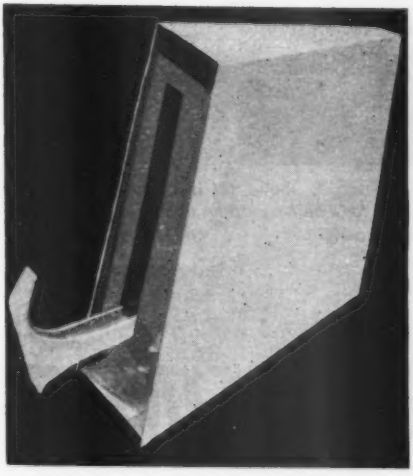
The Council has decided to hold a further competition in 1961, which will be organized on the same lines as that in 1960. Particulars of this competition will be published in July, and the list of sections to be included will be announced in the subsequent issue of the *Journal*.

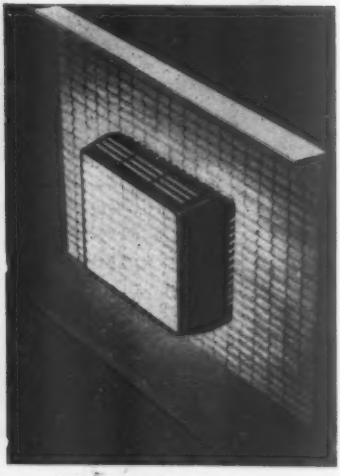
SOME OF THE DESIGNS

All the designs reproduced in these pages were submitted for the Set Tests. The captions are taken from the students' own descriptions

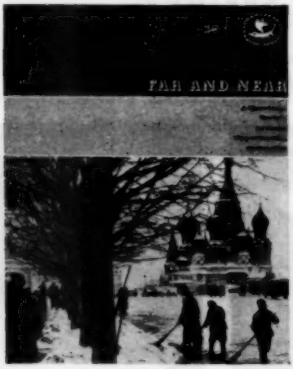


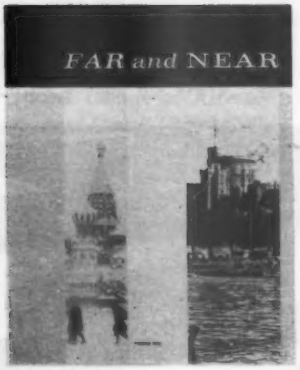
Left, *solid-fuel-burning-openable stove, by Michael Crook.*
Right, *light fitting for a church, by David Pearson*



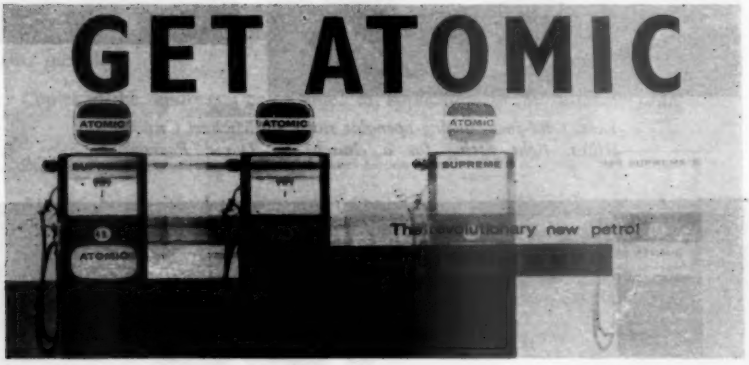


Left, *non-automatic electric toaster, by David Malarkey.* Right, *4 Kw. electric fire, incorporating a lighting effect, by Alan Boyce*

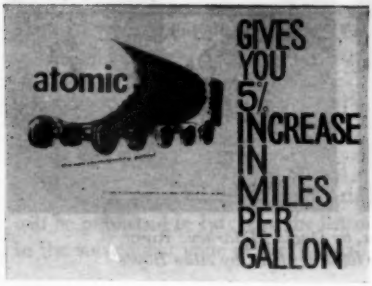




Front cover for projected travel magazine: left, *by David Tudor;* right, *by Marian Kirsner*



Advertising for a new brand of petrol: above, *for a 48-sheet poster, by George Parker;* below, *for a half-page press advertisement, by John Lenaghan* (left), *and Peter Schalkwyk* (right)



Left, *carton for a roll film camera, by Kenneth Reed.*
Right, *polythene bag for woollen wear, by Paul Castell*

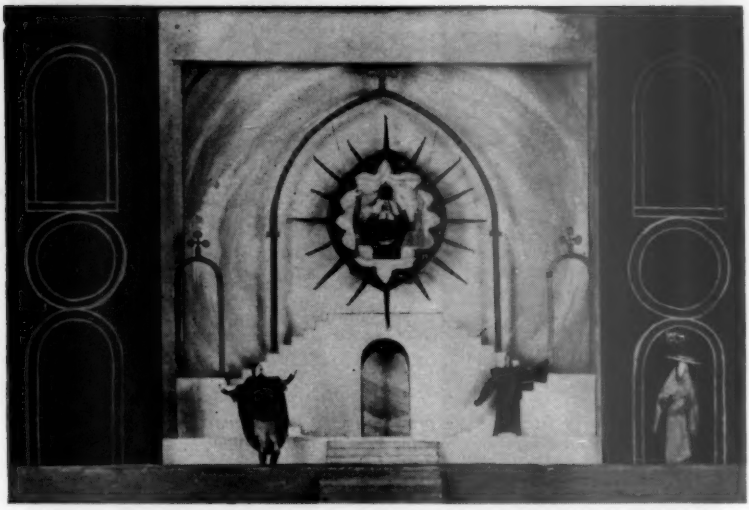
Indoor exhibition stand for 'Elite' Fireworks Company, by Charles Mynard

Left, *formal suit and over-blouse in slubbed wool and silk mixture, for a young woman with a limited budget, by Hilary Floyd.* Right, *cocktail dance pump in white calf, with bracelet and ear-rings, by John Darlow*

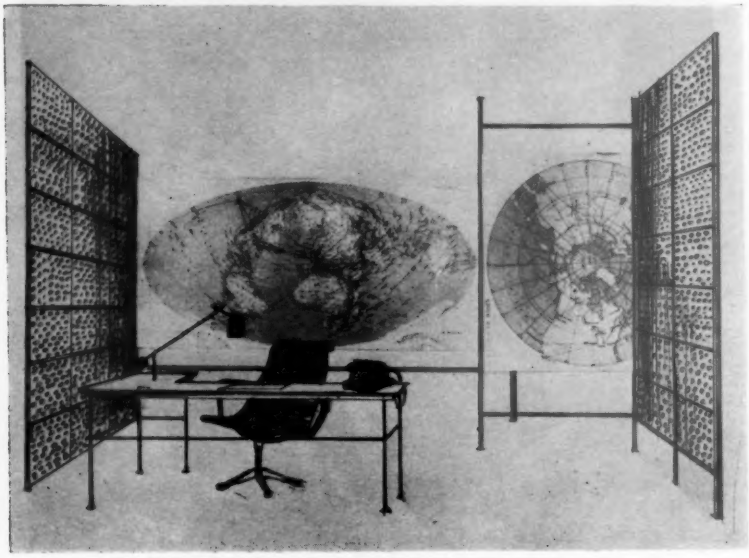
Left, *evening dress in taffeta for a young woman with a limited budget, by June Mackereth.* Right, *casual wear, for a young woman with a limited budget, by Anne Parker*

Left, *plan view of fruit dish for presentation at an international film festival, by Trevor Long.* Right, *printed furnishing fabric for a bungalow, by Cynthia Bingham*

Five-colour, screen-printed 'Everglaze' cotton dress fabric, by James Morgan, who was awarded the SIR FRANK WARNER MEMORIAL MEDAL



Setting for the morality play, 'Everyman', by Michael Pope



Studio background setting for a television news-reader, by Jane Barchard

THE MODERN CHEMICAL INDUSTRY IN GREAT BRITAIN

Three Cantor Lectures by

JAMES TAYLOR, M.B.E., Ph.D., D.Sc., F.R.I.C.,
a Director of Imperial Chemical Industries Ltd.

I. TOWARDS A PHILOSOPHY OF THE MODERN CHEMICAL INDUSTRY

delivered to the Society on Monday, 23rd January,
with Stanley J. Gooding, M.A., M.Sc., M.D., J.P.,
a Member of Council of the Society, in the Chair

THE CHAIRMAN: The development of the chemical industry in the first half of this century has been nothing short of dramatic. As necessity is the mother of invention, under the stimulus of two world wars the chemical industry's development has been truly tremendous. The whole subject makes a fascinating story, and who better to unfold it for us than Dr. Taylor? He is a distinguished chemist and a Director of Imperial Chemical Industries.

The following lecture, which was illustrated with lantern slides, was then read.

THE LECTURE

INTRODUCTION

I am committed to deliver to this Learned Society three lectures on The Modern Chemical Industry. These I have prepared but submit them in some trepidation lest the verdict should be as it was from the critics who received three plays from an unknown author, that they went from bad to worse in whichever order they were read.

In my first address I shall try to establish what the modern chemical industry does, and in what manner it differs from older traditional industries. If we can arrive at some generalization about the industry and its motivation we may be able to understand how and why it has been forged into its present form, and to appreciate its problems and potentialities.

The chemical industry as it has developed to-day in large powerful units throughout the world is typical of the great scientifically based industries which have emerged during the last few decades. These have not arisen fortuitously but are the result of interaction between the forces of business and science.

Our subject is fraught with many pitfalls. One is immediately confronted with the problem of definition. It would have been simpler to speak of chemistry in industry, or better still, of the chemist in industry. The difficulties are not imaginary, nor do they stem from the fact that I am not a chemist, but a physicist, who for 35 years has been ground down by the carborundum of the large-scale chemical industry into chemical form.

I have, perforce, had to choose a few out of a multitude of parameters as being specially important and I have no doubt that this has led to views which are over-simplified, as is so often the case with physicists, who tend to see order and cause where perhaps only chaos prevails.

Much has been written about the rise and development of the chemical industry, and since many more able than myself have dealt with these matters authoritatively, I propose to quote from them where appropriate, with the object of providing a background for the consideration and understanding of the modern chemical industry in this country.

I shall also quote from some of my own previous addresses. I apologize for this but it arises from the fact that on many issues I have not changed my views and, having spent a great deal of time in trying to express them clearly, there is little point in rewording them.

PRESCIENTIFIC INDUSTRY

In order to appreciate the essential characteristics of the modern chemical industry it is useful to look at the past.

The chemical activities of man can be divided historically into two periods, the pre-scientific and the scientific. Pre-scientific industry was traditional and empirical, based on crafts which were appropriately described as 'mysteries'. Advances occurred rarely and slowly: the lack of quantitative knowledge and science made progress extremely difficult. This is not hard to appreciate when we remember, for example, that there was a period when craftsmen could not distinguish clearly between sodium carbonate and potassium nitrate and called both 'nitrum'. Following the great advances in chemical science towards the end of the eighteenth century by the work of Lavoiser and Dalton, traditional chemical manufactures came under the influence of chemical science and began to be transformed from empirical crafts to industries *informed by scientific principles*.[1]

Thus far we are on fairly safe ground, but it is a commonplace that most progressive industries since the industrial revolution have been 'informed by scientific principles'. What has varied is the degree to which they have been 'informed'.

THE SCIENTIFIC CHEMICAL INDUSTRY

The utilization of chemistry or of chemists in crafts, arts or industries does not necessarily bring them into the fold of the chemical industry.

S. P. Chambers wrote recently:[2]

> Because of its diversity and the obscurity of its boundaries, the chemical industry is a difficult one to review, and the statistics are unsatisfactory. The Census definition of 'Chemicals and Allied Industries' includes a number of activities which are not normally regarded as belonging to the chemical industry, such as the manufacture of hoof meal and night-lights.

We must distinguish between 'Chemicals and Allied Industries' if we are to reach any real understanding of the essential characteristics of the modern chemical industry. We can go some way to this if we recognize that a considerable number of industries are still 'mysteries' though they are informed to a greater or less

extent by scientific principles. If the mystery is substantially greater than the degree to which they are informed, I believe they cannot be included as parts of the modern chemical industry. No doubt if a chemist made this assertion he would be considered arrogant, but that would not be correct: on the contrary, the view is derived from humility. The layman considers chemical science to be advanced and fit to cope with even the most complex and difficult features of chemical compounds in Nature. This, paradoxically, is not true. The fact is that chemical science at the present time can only deal with relatively—and I stress relatively—simple matters and is powerless to cope with the complex body of chemical activities and processes which must proceed if normal life is to continue. It is salutary to contemplate Nature and reflect that the humblest organism can produce chemicals such as penicillin and streptomycin which task the skill of the most able chemists to determine the formulae, and for which, in many cases, they can find no synthetic route. The youngest baby produces hormones and all sorts of chemical substances of complexity beyond anything that can be understood, let alone synthesized, by the chemist. Even in simpler matters, Nature scores over the chemist. No man-made fibre, for example, is so perfectly circular in cross-section as the cotton fibre. Nature has certainly not produced a wheel, but neither is she responsible for the appalling congestion of wheels in London. Even our latest and best electronic brains have millions fewer channels than Nature has provided in man's own brain. It is clear, then, that Nature, through chemical processes which far transcend those devised by man, can produce products to which at present there is no access through man-made science. Industries based on this natural chemistry, such as agriculture, the traditional fermentation industries and leather may be assisted by science, but they are still arts and crafts. This is not a static state of affairs, and as man's science progresses, arts are transformed into chemistry. A classical example of this is the synthesis of indigo. In 1880 after seventeen years of research, Baeyer discovered a synthetic route to the preparation of indigo and during the next decade it was brought into large-scale manufacturing use in Germany. This ruined indigo planting in India and the cultivation of woad in Britain, thereby ending an old indigenous traditional industry.[3] Thus an ancient art and craft came into the chemical industry. The recent synthesis of natural rubber may well provide another classical example in the future. It can be appreciated that as chemical theory advances, more and more of the 'mysteries' will come into the fold of the chemical industry.

What I have said helps us to understand the nature of the chemical industry but it does not explain many of the anomalies which exist within it. In this connection we must clearly distinguish between the chemical industry and chemical firms. Chemical firms include activities which do not by any stretch of the imagination belong to the chemical industry, and other industries include activities which are unquestionably chemical.

WHAT THE CHEMICAL INDUSTRY COMPRISES

As to what comprises the chemical industry, there appear to be very different opinions. The *History of the British Chemical Industry*, which was written for the

Jubilee of the Society of Chemical Industry in 1931, includes the industries shown in Table I.

TABLE I

THE BRITISH CHEMICAL INDUSTRY

(*according to Miall*)

The heavy chemical industry
The dyestuffs industry
The fermentation industries
Drugs and fine chemicals
The chemical industry of cellulose
Metallurgy
Gas, coke and tar
The paint and varnish industry
The soap industry
Miscellaneous (cement, plastics, matches, water-softeners, linoleum, paper, explosives, margarine, salt, glass, electric batteries or accumulators)

Sherwood Taylor in his *History of Industrial Chemistry* (1957) includes metallurgy, not only in his section on the pre-scientific, but also in that dealing with the scientific chemical industries. In the latter section he also includes industrial biochemistry.

I think that these inclusions are justified in these particular works as the S.C.I. was clearly dealing with the chemical activities of industry in so far as they were a subject matter of the Society which is a forum for the chemist in industry, rather than for the modern chemical industry. Sherwood Taylor was dealing with industrial chemistry and not with the chemical industry.

Haber, in his recent work[4] does not include the fermentation industries, nor metallurgy except that he makes some reference to aluminium and the less common metals.

As regards the difficulty of definition, T. I. Williams[5] considers 'it is like trying to define where, on the fringes of a great city, the town ends and the country begins'.

Inquiries from the President of the Board of Trade to the Association of British Chemical Manufacturers in 1948 led A.B.C.M. to make a study with the object of recommending what activities ought to be included in the chemical industry. The final view reached was that the chemical industry should include the manufacture of heavy chemicals, industrial gases, fertilizers, dyestuffs, medicinal and fine chemicals, explosives, plastics and synthetic resins. The compounding or mixing of chemicals to produce paints, insecticides, sheep and cattle dips, pharmaceuticals and the like, was not regarded as part of the chemical industry.

It would appear that this classification arose from the view that it was the business of the chemical industry to make chemicals but not to compound them to produce 'effects'. There is a certain simplicity in this view, but it is too restricted in to-day's circumstances.

To complete this survey of opinion I would refer to a recent review by the

Chairman of I.C.I.[6] The sub-divisions, included in his Sector Study, are shown in Table II.

TABLE II

THE BRITISH CHEMICAL INDUSTRY

(*according to S. P. Chambers*)

Inorganics
The old-established organic chemical industry
The newer bulk organic chemicals
Plastics
Synthetic rubber
Man-made fibres
Synthetic detergents
Solvents and plasticizers

Chambers does not include the metal industries, the traditional fermentation industries or paints in his classification.

With respect to metallurgy, I believe that large-scale industries with a long history pre-dating the chemical industry and in which the mining of ores and the fabrication of the metal play a predominant part can reasonably be regarded as being independent industries, although they do utilize important chemical processes. This is less readily understood in the case of the aluminium industry, which is recent and based on new chemical processes; especially so when one recalls that the production of sodium, potassium and calcium are part of the chemical industry and it appears likely that the extraction of the new metals such as titanium, which involves so many difficult chemical problems, will remain part of it.

The petrochemical activities of the petroleum industry are now, as we shall see, definitely part of the chemical industry.

To summarize, it appears reasonable to regard the modern chemical industry as being derived from the earlier traditional manufactures 'informed by scientific principles'. If this is accepted we can go on to discuss the main components of the industry as given by Chambers (Table II).

THE INORGANIC CHEMICAL INDUSTRY

The modern chemical industry was established during the nineteenth century to supply the increasing demands for acid and alkali resulting from the industrial revolution. Sulphuric acid and alkali (soda ash) were, and still are, the workhorses of many industries and are required in enormous quantities. Processes of manufacture derived from chemical science were established during the last century and the early part of the present century and founded the chemical industry as we know it.

In the contact process for sulphuric acid, sulphur, or a sulphide ore, is oxidized to form sulphuric trioxide. The sulphur trioxide is dissolved to produce either oleum or sulphuric acid.

Thus: $S + O_2 \longrightarrow SO_2$

$SO_2 + \frac{1}{2}O_2 \longrightarrow SO_3$

$SO_3 + H_2O \longrightarrow H_2SO_4$

This is a simple process defined by precise chemical equations.

The ammonia soda process, conceived by Ernest Solvay and brought into practical production in Belgium in 1861, consists essentially in reacting common salt and ammonium bicarbonate in a cold solution to form sodium bicarbonate which is precipitated and ammonium chloride which remains in solution, thus

$$NaCl + (NH_4)HCO_3 \rightleftharpoons NaHCO_3 + NH_4Cl$$

This again is a double decomposition process defined by precise chemical equations.

Another important work-horse is chlorine, originally made by treating salt and pyrolusite with sulphuric acid, later by the Deacon process, and used for the preparation of bleaching powder. Advances in electro-chemical science, however, enabled an elegant process to be developed in 1895 for the production of chlorine (and caustic soda) by electrolysis of brine, and this has superseded the old process.

Inorganic chemistry was the branch of the science which was first systematized and quantified and it was the inorganic chemical industry which first acquired the characteristics which we now recognize as inherent in a scientifically based industry.

Further great advances in the heavy inorganic chemical industry, which I shall touch on later, occurred during and after the First World War.

THE ORGANIC CHEMICAL INDUSTRY

The second half of last century also witnessed a great flowering of organic chemistry and its establishment as a science which furnished great opportunities for synthesis of naturally occurring and novel chemical substances. Many examples could be cited, but the most important from the point of view of our present studies are the Dyestuffs and the Explosives industries.

In the Sir William Jackson Pope memorial lecture to this Society last year, Paine indicated that there are now of the order of 3,000 dyes in commerce, and that about 200 of these have outstanding properties. 'Underlying this profusion of colour is an intricate and fascinating pattern of organic chemistry.'[7]

Dyestuffs chemists were not, however, merely producing new colours but were also concerned with their use in dyeing textiles. This promoted their interest in textile fibres and led them into new paths of chemistry, including, in due course, plastics and man-made fibres.

The explosives industry, originally based on gunpowder, a mechanical mixture of charcoal, sulphur and saltpetre, made a revolutionary step forward in the late 1860s when Alfred Nobel exploited the basic discoveries of nitroglycerine and fulminate of mercury, thus bringing into being the modern explosives industry. The new explosives were organic compounds which could only be prepared by carefully controlled chemical reactions. Thus nitroglycerine, glyceryl trinitrate, is a typical 'text book' reaction product prepared by nitrating glycerine with a mixture of nitric and sulphuric acids.

$$C_3H_5(OH)_3 + 3HNO_3 \longrightarrow C_3H_5(ONO_2)_3 + 3H_2O \text{ (taken up by the } H_2SO_4)$$

The explosives industry was important first of all in that it brought many chemists into industry and secondly that it led to the modern developments in the fixation of nitrogen which gave profound impetus to all synthetic chemical processes.

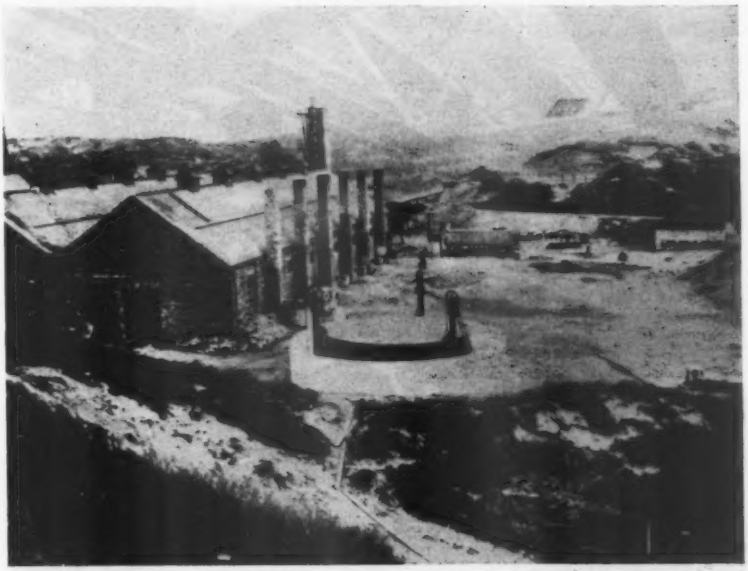


FIGURE 1. *Exterior view of a pot process nitric acid plant about 1890. This plant used as its raw material Chile saltpetre*

We observe then that first inorganic and then organic chemistry 'informed' the earlier empirical industries.

THE MODERN SYNTHETIC CHEMICAL INDUSTRY

In my view the present large-scale chemical industry has its roots in the Haber process. Fritz Haber is an outstanding example of the scientist who applied his knowledge to industry. Originally interested in electro-chemical research, he later turned his attention to studies of gas equilibrium and in 1905 published an important work, *Thermodynamik Technischer Gasreaktionen.* As a result of brilliant researches carried out between 1906 and 1909, he established that nitrogen and hydrogen combined to give a good yield of ammonia gas provided the pressure was raised to the order of 100 atmospheres and the temperature round 1000°K, in the presence of a suitable catalyst. Badische Anilin-und-Soda-Fabrik undertook the industrial development, and by an outstanding feat of chemical technology and engineering evolved a process which, in 1913, produced 1,500 tons of fixed nitrogen and, in the next year, 6,500 tons. Huge quantities of fixed nitrogen are needed for explosives and without the Haber-Bosch process it is doubtful whether Germany would have waged war in 1914, since she was likely to be deprived of the alternative supply of nitre from Chile, by blockade. The process was developed for warlike

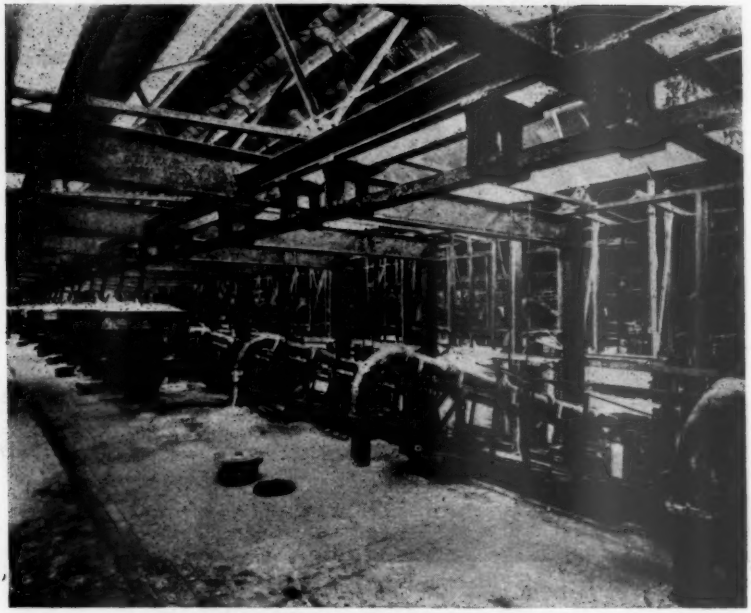


FIGURE 2. *A section of a nitric acid plant, dated about 1923, showing the top of the retorts with the saltpetre hoppers and harts condensers*

purposes, but at the same time, it realized man's dream of abundant fertilizers from the air.

The Haber-Bosch process can be described shortly as follows:

Synthesis-gas, a mixture of CO,H_2 and CO_2 is produced by passing air and steam over red-hot coke. The mixed gas contains N_2 from the air as well as the other constituents. The hydrogen and nitrogen are separated from the other gases and are passed over a catalyst at high pressure and temperature to yield ammonia, thus:

$$3H_2 + N_2 \longrightarrow 2NH_3$$

This is an elegant scientific process, making great demands on high pressure and temperature techniques, and on instrumentation and control. Modern high pressure synthesis processes stem from the pressure techniques introduced into the chemical industry via the synthetic ammonia process immediately before and during the First World War.

The production of ammonia in bulk was also responsible for advances in the manufacture of other chemicals, notably nitric acid. In the old process Chile saltpetre was treated with strong sulphuric acid to yield nitric acid.

$$2NaNO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + 2HNO_3$$

In the new process ammonia gas is oxidized by passing over a catalyst with air, and the resultant nitric oxide is reacted with further oxygen to form nitrogen dioxide which is absorbed in water to form nitric acid. (The difference between the old pot process and a modern plant can be appreciated from Figures 1 and 3.)

I shall now turn to bulk organic chemicals. Originally they were produced from coal and vegetable matter, and still are, but increasing quantities are now made from petroleum feed stocks and by-products, or natural gas.

The alcohols are important bulk organic chemicals, ethyl and methyl alcohols being work-horses of great importance to the industry. Ethyl alcohol is produced by fermentation of sugar-containing vegetable matters. Methyl alcohol was formerly produced by the destructive distillation of wood, but it is now prepared by a synthetic route from hydrogen and carbon monoxide, produced by the water gas reaction, and combined under the influence of a catalyst, such as zinc oxide.

$$CO + 2H_2 \longrightarrow CH_3OH$$

This synthetic route to methyl alcohol from simple gases is a typical example of the processes, which in my view, are characteristic of the modern chemical industry. More generally, they are derived from the Fischer-Tropsch and 'oxo' processes.

The Fischer-Tropsch reaction, also called the gas-synthesis, was invented by Franz Fischer and Hans Tropsch in Germany. Hydrogen and carbon monoxide in proper proportions, and at suitable pressure and temperature are reacted by passing over a solid catalyst (e.g., iron, cobalt or nickel) to form hydrocarbons and oxygenated organic compounds. Products obtained are gasoline, diesel oil and waxes.

The process came into large scale production in Germany in the early 'thirties and was widely used during the Second World War.

An important outgrowth of the Fischer-Tropsch synthesis is the 'oxo' process: Solvent and plasticizer alcohols are produced by reacting an olefine with carbon monoxide and hydrogen in the presence of a catalyst (i.e., cobalt carbonyl) at several hundred atmospheres pressure, and temperature of the order of 150-200°C. Synthesis of the alcohols is a two-step process. The 'oxo' reaction produces an aldehyde, and this is hydrogenated in the second step to produce the corresponding alcohol.

It would be possible to go on for a very long time describing other processes used to-day, but I am of opinion that I have given sufficient description to show that modern chemical processes increasingly comprise synthetic routes which demand a quantitative knowledge of the chemical reactions involved, and very advanced technologies.

Dr. J. G. Cockburn has pointed out to me that physical chemists played a great part in the developments I have just described, and that the rôle of the physical chemist in making the more spectacular industrial advances possible arose from his interest in the dynamic aspect of chemical reactions; from his preoccupation with what was going on and not in what went in and what came out.

Thus in the high temperature-high pressure field the very remarkable engineering advances in plant could not begin until the kinetics, not merely the overall reaction, were understood.

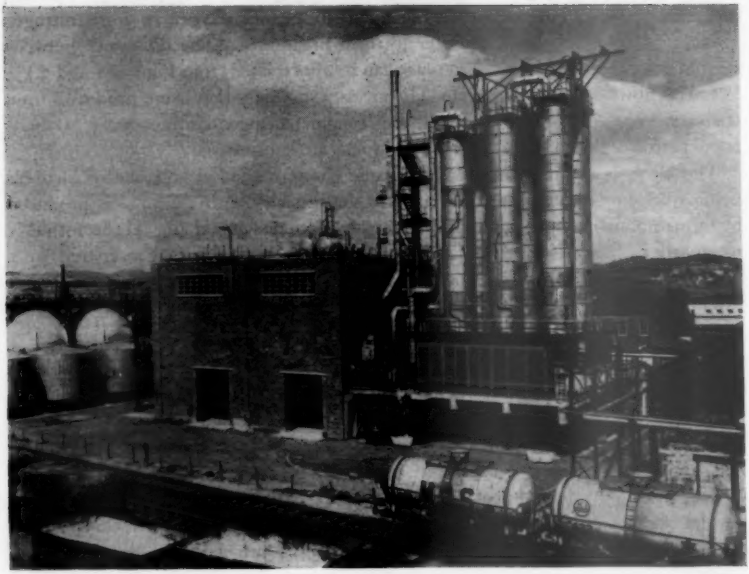


FIGURE 3. *A modern nitric acid plant, 1960. This plant operates an intermediate pressure oxidation system using liquefied ammonia*

For example, reactions are accelerated by rise of temperature, and some elevation of temperature level may be necessary to obtain a product in a reasonable time, but very often heating may oppose the reaction in the direction one wishes it to proceed and only rise of pressure may resist this effort. The balance between such opposing tendencies, and the solution of the engineering problems they give rise to, is at the very foundation of all the largest synthetic industries of modern times.

PLASTICS AND SYNTHETIC FIBRES

I should now like to consider plastics and synthetic fibres.

Plastics have a fairly long history going back to celluloid (1872) and phenol-formaldehyde plastics as pioneered later by Baekland (bakelites). Nevertheless, the modern plastics industry is quite different both in quality and in form from its antecedents. The plastics industry depends on the science of polymers, that is the science of giant molecules, and is of recent origin. Polymeric Science includes not only the wide range of modern plastics, but synthetic rubber and man-made fibres.

The modern plastics industry probably dates from 1927, when du Ponts initiated fundamental research on polymerization in their laboratories. Hard on this came Carrother's classical researches on the structure and synthesis of long-chain mole-

FIGURE 4. *View of the first-ever polythene plant at Wallerscote works, Cheshire. It came into operation just at the outbreak of the Second World War and was able to provide much-needed material for use in the manufacture of radar insulation*

cules culminating in the synthesis of nylon. Thus began the great developments in polymer science which later enabled Whinfield and Dickson by a brilliant piece of deduction and chemical construction, inspired by Carrother's work, to produce Terylene. Other important plastics came into the picture about the same time, polystyrene in 1930, polyvinyl chloride 1937, polymethyl methacrylate 1933. Polytetrafluoroethylene was as late as 1941.

There was, however, another entry into the modern polymer industries. The earlier chemical enterprises employed inorganic and preparative organic chemists, but there was only a sprinkling of physical chemists, and physicists were practically unknown. Nevertheless, the time was rapidly approaching when scientific knowledge of the physical properties of substances had to be sought by the application of physical chemistry. It was during investigations on the physical and chemical effects of very high pressures on gases that ethylene was polymerized by Gibson and Fawcett in 1933 and polythene, one of the most important synthetic plastics, was discovered. The high pressure polythene process was the only practical one for many years, but it stimulated a great deal of research into the polymerization of olefines and other gases and, in 1953, Professor Ziegler of Müllheim, as a result of some brilliant researches, discovered a process for polymerizing ethylene at atmospheric pressure using complex catalysts, such for example, as aluminium alkyl-titanium tetrachloride systems. Professor Natta of Milan in recent years has extended this type of reaction to crystalline and amorphous poly-olefines, par-

FIGURE 5. *View of a modern polythene plant*

ticularly polypropylene, and new and exciting prospects have been opened up in the field of plastics, films and fibres. We are just at the beginning of this new field of endeavour.

It was inevitable that the employment of physical chemists and physicists, who are concerned with investigating physical properties and effects, would alter the nature of the chemical industry; this is occurring. The impact is spectacular in the field of man-made fibres, and has brought the industry into textile pursuits in a big way. It is considerable throughout the plastics industry and in the field of new metals.

THE PHILOSOPHY OF THE CHEMICAL INDUSTRY

I have, of necessity, had to be selective in the examples I have chosen to illustrate the processes of the modern chemical industry, but reflecting on them, the view can be expressed that traditional industries deal with complex chemical processes which are still outside the quantitative knowledge and control of present-day chemistry, and the chemical industry proper deals with relatively simpler chemistry which is fairly completely elucidated and quantitatively understood.

I realize that in putting forward this view I am emphasizing a present-day, not necessarily a permanent, trend, and that I am less than just to those industries which produce sophisticated products by biosynthesis. I shall endeavour to make some amends in my third lecture.

The arts and crafts can extract and use complex substances produced by Nature with little or no scientific knowledge of the chemistry, whereas the modern chemical industry is concerned with 'man-made' reactions, which even in their simplest form, such as the synthesis of ammonia, need precise scientific knowledge and methods.

As a result of our considerations, I am going to risk a generalization. I suggest that the essential characteristic of the modern chemical industry is that it is primarily concerned with manufacturing chemical compounds by synthetic routes which can only be established through quantitative chemical science.

Heisenberg illuminated this viewpoint when he wrote:

> Chemical technology might still have been considered as the continuation of old branches of handicrafts; we have but to think of dyeing, tanning and pharmacology. But the scope of chemical technology as it has evolved since the turn of the century, no longer permits any comparisons with earlier conditions. Finally, atomic technology is exclusively concerned with the exploitation of natural forces to which there is no entry at all from the world of natural experience.

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1. See Sherwood Taylor, *The History of Industrial Chemistry*.
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DISCUSSION

DR. I. BERKOVITCH: I was interested to note that in Dr. Taylor's address he referred to the engineering of modern plants but not to the engineers. They seem to me a rather important group of applied physicists. Dr. Taylor specifically picked out for mention the work of chemists and of physicists. I wonder if he has any views about the engineers?

THE LECTURER: It is true that I have not specifically mentioned the engineer, apart from including him in the advanced technologies which we must use nowadays. I think I did mention the pressure vessel engineer, but he was the only one. I do not know whether your question relates to chemical engineers or to engineers?

DR. BERKOVITCH: I had in mind both the chemical engineers and the mechanical engineers who specialize in this field in addition to chemical engineers as such. As chemical industry has grown in scale and process conditions have become more severe, their contribution has become as essential as that of the chemists.

THE LECTURER: In the old days it was the rule to have chemists who were associated with engineers who had had practical experience in the trade, and these very often formed good combinations. However, I believe it is now usually agreed that with the advanced requirements it is no longer the solution to the problem and that we need chemical engineers who have had training in the particular disciplines of unit operations, and the like. I feel that it is preferable to have the chemical engineer developed from a chemist who has been trained in pure science and then given a course in chemical engineering, but on the other hand there are schools of chemistry—such as MIT—which start chemical engineering right from the beginning and consider it is a discipline on its own.

In my opinion, there is an important use for chemical engineers in the chemical

industries. This is now recognized, and they are achieving an increasing importance. Probably they are the people who can best interpret flow sheets and chemical data to the constructional engineer, who is still, of course, a mechanical engineer, and the civil engineer, who must play a very important part in all projecting. However, in the considerations I was developing I was not dealing particularly with the engineers who, as a matter of fact, have always been able in this country to achieve a training which is suitable for our requirements. I do not think we in our industries have ever notably been let down by the absence of engineers; with the present technical requirements we may be, but so far we have not.

DR. S. I. LEVY: Having regard to the definition which Dr. Taylor has given us of the chemical industry, would he consider that the modern treatment of oils and fats, and their applications for the manufacture of soap and essences, are within the chemical industry?

THE LECTURER: That is rather difficult. My own view would be that they use chemistry and are 'informed by science' to quite a large extent but would not form part of the modern chemical industry as I see it. However, I am afraid that on this subject there is room for very considerable differences of opinion.

MR. G. F. UNDERHAY: Dr. Taylor has spoken in a very interesting way about the manufacture of polythene by its original high pressure process and also of the Ziegler process which has come into being more recently. As the knowledge of catalysts increases, does he visualize any trend away from high pressure manufacture in favour of low pressure manufacture and therefore in favour of cheaper modes of manufacture generally?

THE LECTURER: I think you are asking me an extremely difficult question, and there are a number of people in this hall who could answer it much better than I.

However, I believe there is no question that the field of chemistry which has been laid open by the type of reaction explored by Ziegler and Natta does make it possible for a considerable number of reactions to be carried out at lower pressures, but it does not follow that because of that they will be more economic in manufacture. Therefore, I feel it is going to be quite a close balance. High-pressure techniques are used and have developed so widely now that they can be embodied in plant which is comparatively cheap and efficient, and I should imagine that for a long time they will be able to hold their own against other processes, which of course have disadvantages in certain ways in the type of carriers which have to be used and the catalysts.

THE CHAIRMAN: It just remains for me to propose, on your behalf, a vote of thanks to Dr. Taylor for his very interesting and stimulating lecture. I know nothing whatever about these things; I happen to be a doctor and I am nothing to do with the chemical industry. I do not know why I am here, but I have learned that the chemical industry ranges very widely. I did think at one time that perhaps you got to know here why some detergents wash whiter, but we have not heard about that!

I remember when I was an undergraduate in Cambridge many years ago, after the First World War, we did go in for a bit of chemistry and physical chemistry, and even physics. Of course, in those days the physicists were a depressed class—there was no opening, no future for them—but the thing which struck me then was how very good the Germans were at this sort of thing. Listening to Dr. Taylor this evening we have heard again and again of Franz Fischer and Haber and other Germans; after the First World War when I was an undergraduate, unless you spoke or read a little German you were at a loss if you were reading chemistry or physical chemistry. I used to wonder why it was that they were so very good at it. I suppose now it is the Americans, but I would not be sure!

I am sure you have enjoyed the lecture this evening very much. I have, and I am so ignorant that I have learned a tremendous amount.

The vote of thanks to the Lecturer was carried with acclamation, and the meeting then ended.

II. THE SPRINGS OF PROGRESS

delivered on Monday, 30th January, 1961, with Sir Robinson, O.M., Past President, The Royal Society, in the Chair

THE CHAIRMAN: The time-honoured cliché that our lecturer needs no introduction from me, or to this audience, is much more appropriate than usual to-day because, apart from our general or special knowledge of him, he has already been efficiently introduced a week ago. I believe that the audience to-day consists largely of Oliver Twists who have come back for a second helping. In any case the introduction which Dr. Gooding gave was quite adequate from the personal point of view. Dr. Stanley Gooding was an expert in regard to a different chemical industry, namely, that of the bee-hive. It is interesting that, in any case, he refrained from odious comparisons.

Dr. Taylor has been at pains to define what he understands—at least for the purpose of these Cantor Lectures—to be implied by the phrase 'chemical industry'. He has done this very acceptably in the present connection, but perhaps a small *caveat* may be recorded. We remember only too well how that simple word 'chemical' became a prized asset of certain members of the legal profession. For legal and governmental purposes I hope Dr. Taylor will accept a somewhat wider definition: say, for example, the industry involving transformation of chemical substances.

To-day we shall hear authoritative case-histories of I.C.I. and Shell. The choice, even if inevitable, is a very happy one because it does illustrate two of the main types of sources. Having swum in both streams I am aware of a few contrasts and more similarities. It will be most intriguing to hear Dr. Taylor's comparison and his counsel on what is needed for convergence on the supreme objective, which I am sure we all agree is the most economic production to meet the growing needs of the community.

The lecture, which was illustrated with lantern slides, was then read.

THE LECTURE

INTRODUCTION

So far I have dealt with the scientific aspects of the chemical industry, but all modern scientifically based industries comprise much more than these, and certainly neither chemistry nor science alone would have been capable of producing them. The essence of the modern chemical industry as I have described it, is that it manufactures chemical compounds, sometimes of considerable complexity, synthetically from simple constituents such as nitrogen, oxygen, carbon dioxide, carbon monoxide, hydrogen and the gas constituents of the cracking of petroleum or from natural wells. This may be what the industry actually does, but it is at once evident that without qualification as to scale, these activities could equally well, or better, be carried out in university or other research laboratories.

THE COMPONENTS OF THE CHEMICAL INDUSTRY

The essential additional feature is that these processes are carried out on a very large scale indeed, and modern plants turn out not grams, but often thousands of tons per week. The design and construction of such plants involves complicated

and difficult techniques, often with new materials of construction and highly sophisticated instrumentation and control, of a nature which were not available until science had developed adequately its technological functions. The plants are extremely costly and can only be financed by powerful concerns which can afford to wait a few years before the plants come into beneficial production.

It will be readily understood, then, that the industry as it exists to-day has a profound content of science, technology, finance, business and management, and that it differs from its predecessors and from many other present-day industries in that these component elements, instead of being left to chance, have been subject to quantifying processes of organization to fit them for servicing large-scale enterprises.

The chemical industry the world over includes a number of very large organizations. These may arise in a number of ways—by merger of a number of chemical firms accompanied by a development of technology and of managerial resources, as in the case of I.C.I., or by direct incursion of an already powerful company with technological and managerial resources into a new field of chemistry, as in the case of the Royal Dutch/Shell Group. By whatever path they have arrived, such large corporations are the result of a partnership of science and business over many years.

In order to understand the present chemical industry in Great Britain, we must look at the past and consider the springs of progress. I propose to do so in this lecture.

THE EARLY DEVELOPMENT OF INDUSTRIAL CHEMISTRY

The early development of industrial chemistry depended largely on individual enterprise and effort. One of the characteristics of the chemical industry of last century was the part played by the individual who combined scientific knowledge of chemistry with business ability. Such individuals arose in a number of countries, but the conditions in Germany at that time were peculiarly favourable for such. The German universities provided outstandingly good facilities for chemical training, and the whole climate favoured its utilization in industry. British industry owed much to such individuals, and specifically, to Germans of Jewish extraction. Many Jews have a natural gift for combining learning with affairs. Rudolph Messell, Ivan Levinstein, Otto Witt and Ludwig Mond are examples.

Britain produced a considerable number of chemist-businessmen, but often they had not the advantage of a basic training in chemical science, such as Germany provided. Nevertheless, the list is impressive and includes names such as Charles Tennant, James Muspratt, Alexander Chance, Walter Weldon and Sir William Perkin.

One of the most outstanding examples of the chemist-businessman was Alfred Nobel, a Swede and the founder of the Peace Prizes.

The day of the individual chemist-businessman has gone so far as the large-scale modern industry is concerned, but it has not gone either in the chemical industry or in industry generally, and I could give several examples of individuals with a clear technical view of a particular need combined with business competence, who have established important and growing businesses. This is good

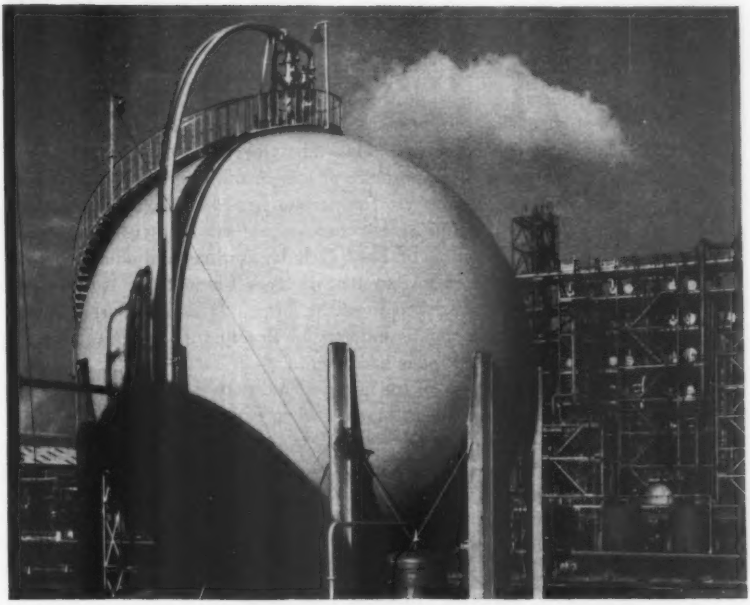

FIGURE 1. *Typical of the strange but attractive vessels which are part of the modern scene in the chemical industry is this vessel used for the storage of ethylene*

and we should not be so obsessed with big business as to overlook such activities which in total contribute much to the national product.

Later in the nineteenth century

> the chemist-businessman almost disappeared in Britain and was replaced by competent businessmen with little technical training.
>
> The British Chemical Industry was overtaken by that of Germany, where the community was much interested and concerned with the chemical industry and where, owing to the provision of opportunities for scientific training, the manufacturers could 'tap' a large reservoir of extremely capable chemists whose enthusiasm for research, often of a painstaking, routine nature, was unmatched in other countries, except Switzerland.[1]

In Britain it was years later that scientific and technical training, fortified by the growth of the provincial universities, and management perception, sharpened by war and economic necessity, produced an analogous climate.

THE IMPETUS OF THE FIRST WORLD WAR

The First World War gave an enormous impetus to the chemical industry—indeed, the Kaiser's War has been referred to as the chemist's war. It was soon

brought home to us that we had relied on Germany for many organic chemicals, particularly dyestuffs, and that our chemical industry was in no position to produce the numerous chemicals needed to wage war in the twentieth century.[2] Vast quantities of various chemicals were required for manufacturing explosives and munitions of war, and in order to do this successfully, many able men, including a large number of chemists, were brought into Government service and obtained experience in large-scale chemical operations. The Government and nation began to recognize for the first time the importance of science and technology.

Before the end of the war a number of important steps had been taken towards creating the conditions for a sound British chemical industry. 'In 1915 the British Government acquired the business of Reed Holliday & Sons and equipped it at considerable cost, changing its name to British Dyes Limited. In 1919 British Dyes and Levinsteins amalgamated to form the British Dyestuffs Corporation.'[3] This established the modern dyestuffs industry in Britain with the heavy task of making up for all the years the locusts had eaten.

A vital step in the development of the chemical industry, as we know it to-day, was taken by the British Government in 1917 when it decided to investigate the Haber-Bosch process.

At the end of the war the Government turned over its experimental ammonia project to private enterprise (Brunner Mond & Co. Ltd.). A pilot plant came into operation in May, 1921, and this was the forerunner of the great chemical manufacturing complex at Billingham.

IMPERIAL CHEMICAL INDUSTRIES

In the immediate post-war period some, at least, of the lessons of the war had been remembered and there was a widespread determination that the country must continue its efforts to establish its own chemical industry independent of foreign countries. From this stems the immense progress and reorganization which took place during this period. The pre-war chemical firms, with a few exceptions, were small affairs inadequately equipped technically and financially for the large-scale operations needed to establish vigorous and progressive units, but the war had thrown up many capable men and given them the knowledge and experience to innovate, consolidate and advance, and the stage was set for a massive application of science, technology and finance to the industry.

I was trained immediately after the First World War and, after studying physics at universities both in the United Kingdom and in Europe, I was working in the Cavendish Laboratory and looking out for a job. I am afraid that like many young men at that time I had somewhat of a contempt for the pursuit of science for utilitarian ends and a reluctance to participate in industry. Possibly, this is the reason why I have tried to make amends in some of my recent addresses. Nevertheless, I wanted to get married and good jobs were not easy to come by. I obtained a post at Nobel's in Scotland in 1928. In this manner I entered the chemical industry just after the formation of I.C.I. (1926) and thus by chance have seen the establishment and growth of one great business which typifies the large-scale chemical industry. I.C.I. was formed by the merger of British Dyestuffs

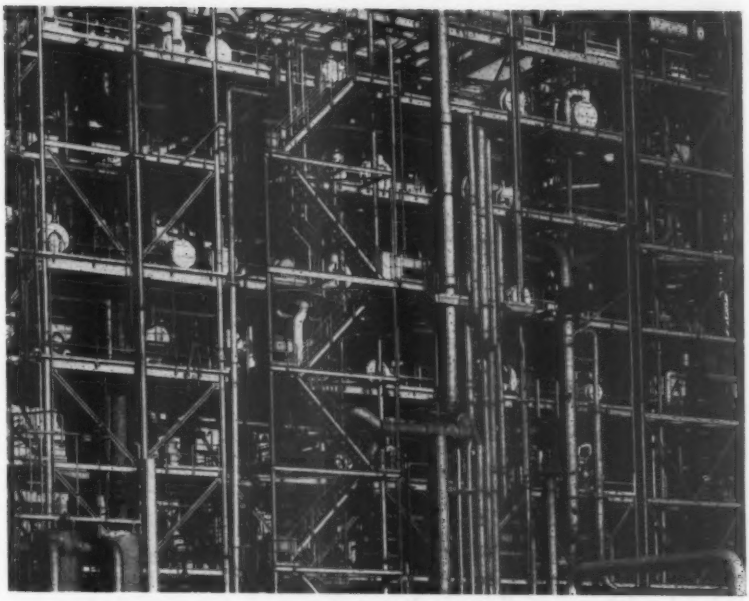

FIGURE 2. *The complexity of some of the modern chemical processes is illustrated by this photograph of the main fractionation unit of an olefine plant*

Corporation, Brunner Mond, Nobel Industries, and the United Alkali Company. The Chairmen of these four companies, in a document to their Shareholders, gave their reasons for proposing the merger as follows:

> Our responsibility to you for the conduct of your great Companies has naturally imposed upon us the duty of following studiously the trend of economic events throughout the world and, in particular, the development of industrial organization. In this connection it has become more and more evident to us in the last few years that the economic movement towards groupings of great industrial, financial and technical strength, both on the continent of Europe and in the United States of America, is a development to which British enterprise cannot remain indifferent. This tendency, which has manifested itself in so many industries, has not been absent in the chemical industry, in which your Companies are especially interested. There have been brought into existence, both in Europe and America, large and powerful combinations commanding huge resources in equipment, technique and finance, with which we shall have to deal in carrying on the affairs of your Companies. Powerful as each participating Company may be, there is no doubt in our minds that these circumstances call for even greater strength, which can only be attained by a union of interests such as will be achieved by the successful establishment of Imperial Chemical Industries Limited. We feel strongly that

> this union will enable us, as leaders of the chemical industry in Great Britain, to speak with a united voice and present a united front either at home or abroad, in negotiations with Governments or in competition or negotiation with individuals. United in this manner your Companies will possess that force and power which are essential in the world conditions we have outlined.
>
> We need hardly dwell upon the obvious advantages which are to be derived from the co-operation of those engaged in the same line of work. The economies to be achieved in the administration, commercial and technical spheres of the Companies' activities are, in our opinion, so self-evident as not to need elaboration. Unnecessary duplication of capital expenditure can be avoided, research work, so vital to the chemical industry, can be concentrated, costs can be reduced by the interchange of technical knowledge on processes and patents. It is difficult to over-estimate the importance of the benefits which are so anticipated. Where different Companies produce the same articles, or require each others' products—as is the case with the four Companies which are participating in this fusion of interests—mutual assistance in production and mutual benefit in inter-company trade are bound to follow.

And finally:

> Combining the command of adequate financial resources and wide commercial experience with scientific and technical abilities of the highest order, the new Company will, we firmly believe, be in a position to grapple successfully with every such problem however large and however difficult; and the results should, we confidently anticipate, be as profitable to the Shareholders as they will be beneficial to the community.

All the four participating companies had powerful scientific and technical resources, and their technical affairs were carried out by scientists, but their Boards included mainly men of affairs. At the present time, 34 years since the formation of I.C.I., there are 16 full-time Executive Directors, of whom 13 are professionally trained scientists.

During the same period the payroll workers in the Company have increased from about 40,000 to 75,000, but the technical staff has increased from about 3,300 to nearly 17,000.

At the time of the formation of I.C.I., I estimate that not much more than half a million pounds per annum was spent on research and development, whereas in 1959 the expenditure was over £14 million. The capital and surplus assets of the I.C.I. Group during this time have increased from about £65 million to £660 million and the annual capital expenditure on plant, equipment and property from £5 million to nearly £42 million per annum. Group sales have increased from about £72 million to £508 million in the same period.

THE SCIENTIST AND BUSINESSMAN IN THE MODERN CHEMICAL INDUSTRY

The picture I have painted shows the development and transformation of a merger of chemical manufacturing concerns which were operated by technical people, but controlled by 'men of affairs' into a very much greater chemical enterprise operated and controlled by Directors, of whom the majority are men of scientific training. I do not imply by this that the 'men of affairs', the commercial men and the financiers, are not a vital directing part of the undertaking, but the change of balance cannot be disputed.

FIGURE 3. *A panoramic view of part of the Billingham works. The overhead pipe bridges seen in the foreground are typical of chemical industrial architecture of the* 1930s

It is clear then that during the last few decades the interplay of the forces of industry and science has resulted once more in the emergence of the chemist-businessman and the scientist-businessman as an important component in the modern chemical industry.

I think it is appropriate to consider this current position in relation to the view given in my previous lecture that modern industries are 'informed by scientific principles'. Industry looks to science to provide the basic chemistry for the understanding of its processes, and the discoveries for future expansion: it depends upon the scientist for the technology required effectively to carry out present manufactures and establish the new. Equally important, the scientist has achieved a balanced partnership with the businessman and can now play his full part, not only in the specialist scientific aspects, but in all the complex affairs of the industry. Scientifically-trained people have achieved in considerable numbers positions of general and administrative responsibility. In I.C.I., for example, there are men of scientific training widely disseminated in the financial, commercial, sales and personnel departments throughout the Company. This has had the inevitable result that the scientific approach and methods are being applied to all the activities in the industry.

In other addresses I have stressed the importance of the scientist in industry, perhaps too much, because I have given the impression in some quarters that I under-rate the contribution of other professional and managerial classes. On the other hand, since I have claimed that the scientist must come down from his ivory tower and play a full part in industry, I have given the impression to others that I am indifferent to the vital importance of pure science. Neither is true. I agree with Sir George Thomson's view as expressed in his Presidential Address to the British Association last year that 'Science is not merely the control but also the understanding of nature. Its two aspects must be held in equal honour.'

Since, however, I have stressed the necessity for the scientist to become a businessman—and I do not accept the jibe that he does this because business is easier—and may have given the impression that he becomes a better businessman than other people, I want to make some amends and bring into correct perspective the other components of the partnership.

The fact is that large scientifically-based chemical companies must be competent at all levels, including Board level, to deal with the chemistry and technology, including chemical, mechanical and constructional engineering, involved in their projects and processes. They must also be competent to deal with the financing and control of very large projects, with management in all its aspects, and with sales. The degree of specialist knowledge required at the different levels naturally varies, but competence at all levels is a necessity.

It will be evident then that a high scientific and technological competence must characterize the Board of a modern scientific undertaking, and consequently many of the full-time Executive Directors must be professionally trained scientists and technologists who have acquired business and financial experience. It is equally obvious that a proportion of the full-time Executive Directors must be professionally trained financial men, economists, businessmen and the like. I believe that it is necessary for such men to achieve a general understanding of the main processes and subject matter of their industry. Only full-time Directors can be expected to devote the time required for this, and that is the reason why there is a high proportion of Executive Directors in modern large-scale scientific industries. This view does not deny the valuable part played by non-Executive Directors who, as distinguished men of affairs and business, provide that balance and wide judgement which is a leaven to any Board.

THE ROYAL DUTCH/SHELL GROUP

In I.C.I. we have one example of how a large modern firm has been produced by merger of a number of chemical firms, some of which went back to the pre-scientific period (e.g., the gunpowder factories). This has resulted in a large organization commanding adequate scientific, technical, financial, business and management resources for the large-scale chemical industry.

There are, however, other ways in which a large-scale scientific chemical industry can come into being. Shell supplies a good example.

To quote from their own description, 'The Royal Dutch/Shell Group is a world-wide organization which embraces every phase of the oil industry: exploration,

[*Shell Photograph*

FIGURE 4. *The oil distillation unit at Shell Haven. The photograph shows the similarity of the plants used in the oil industry with those now used in the chemical industry*

production, transportation, storage, manufacturing and marketing'. Its balance sheet assets at the present time are worth more than £2,000 million and its income is over £175 million. Its ramifications are world-wide and it is truly an International Company; an integrated oil enterprise operating in all parts of the world.

The Royal Dutch Company was formed in 1890 and the Shell Company in 1897. Their antecedents, of course, have a longer history: the modern oil industry is regarded as starting in 1859, when the first oil well was drilled in Pennsylvania.

The amalgamation of the interests of Shell and Royal Dutch was brought about in 1907. It has thus operated as a vast, powerful, and technically competent Group for over fifty years, i.e., nearly twice as long as I.C.I.

The operations of the Group in prospecting, drilling and production, and in refining, transport and storage, have a high scientific and technological content, and the scale of the operations has demanded an organization competent and experienced in large-scale financing, projecting and management. For many years it has been an industry 'informed by scientific principles'. Nevertheless, it was not, nor did it claim to be, part of the chemical industry.

The four pillars of refining, as Shell picturesquely describe them, are distillation,

cracking, extraction and chemical refining. These operations were employed to produce first of all lamp oil, then gasoline, lubricating products, white oils, paraffin wax, bitumen and fuels. These activities, together with field operations such as deep drilling, called for many skills and for the development of engineering materials of construction, high-pressure installations and much else which could readily be applied to the modern chemical industry. Here in Royal Dutch/Shell was an organization with all the financial, technical and management resources for the chemical industry. And it had more; it had a vast potential of raw material for making chemicals.

Some attempts were made to prepare chemical compounds from petroleum as early as 1913, but Shell's own view is that 'The idea of a petrochemical industry could not thrive before 1927-8, when large quantities of surplus cracking gases and vast supplies of natural gas and gases from oil wells, far in excess of fuel requirements, became available'. The work of Badische Anilin on the synthesis of ammonia and of I.G. Farben on the hydrogenation of lignite to 'synthetic oil' had, as we saw earlier on, opened the door to modern synthesis of chemicals. Thus we see that the modern chemical industry for the oil firms, as for the chemical firms, began in the middle 'twenties.

In 1927 the Royal Dutch/Shell Group set up a chemical industry department with facilities for research in Holland and America. 'The task of the new research staff was to determine, out of all the abundant possibilities offered by chemical theory, what could and should be produced, how this should be done, and the degree of purity required.' The basic materials studied were natural gas and cracked gases, comprising both saturated and unsaturated hydrocarbon gases. One interesting possibility was the manufacture of ethyl alcohol from ethylene, but in the early days this was not economic because industrial alcohol from fermentation was cheaper. Indeed, it still is in most cases. This illustrates the point I made earlier that man-made chemistry and natural chemistry are competitors. Another interesting possibility was the manufacture of ethylene glycol by the oxidation of ethylene to ethylene oxide. A glycol plant was built in 1937 and was in operation until 1943 at a production of about 300 tons per annum, but really large-scale production was not undertaken until after the Second World War.

The manufacture of petrochemicals by the oil industry was not unattended by difficulties and setbacks, but at the outset of the Second World War it was of sizeable proportions, mainly concentrated in the United States, and more particularly concerned with producing base materials for the chemical industry. Fixation of nitrogen by hydrogen from natural gas had also been established, and a substantial entry into the fertilizer industry had been effected there.

Since 1940 a remarkable expansion of the activities of the Royal Dutch/Shell Group has taken place. This applies to geophysical exploration, oil-well drilling, production and transport as well as in the large-scale entry into the modern chemical industry. Shell furnishes an almost textbook example of the development of one of the great scientifically based industries which are characteristic of the present century. Time does not permit me to go into details of all the chemical developments but manufactures include solvents, detergents, fertilizers, glycol, glycerine,

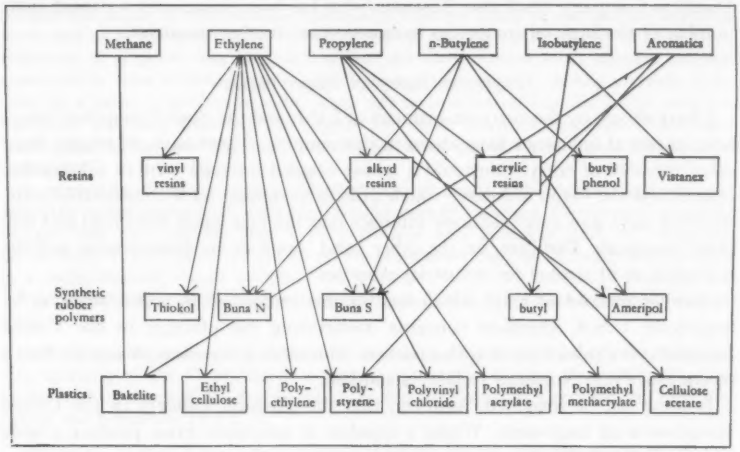

FIGURE 5. *Resins, rubbers and plastics from petroleum*

resins, plastics, synthetic rubber, sulphuric acid, sulphur, ammonia, anti-oxidants and carbon black.

Figure 5, above, illustrates some of the organic chemicals produced and is derived from one of the Shell Publications.[4]

It might be thought that the chemical activities of Royal Dutch/Shell were ancillary to their main oil operations, and therefore did not put them into the modern chemical industry. This is not the view expressed in the *Shell Review 1959*, which states:

> The manufacture of chemicals from petroleum is thus not a separate industry, but is an integral part of the chemical industry, consequently the chemical companies of the Royal Dutch/Shell Group are a part of the chemical industry at large and, therefore, the skills and techniques which these companies employ, the markets they supply and, indeed, their whole operational philosophy must be those of the chemical industry.

This has led recently to the formation of a separate integrated chemical organization to deal exclusively with the chemical activities of the Group.

It is of significance that the amount now spent by the Group on research on chemical processes and products is greater than that spent on oil processes and products. There are about 5,500 personnel in Group research laboratories throughout the world, and the annual rate of expenditure is around £20 million. A great deal of the basic effort is directed towards exploring new syntheses, which it will be recalled was in my view the cornerstone of the modern chemical industry.

The Shell Group was chosen as a case-history because it operates in the United Kingdom chemical industry on its own. British Petroleum, on the other hand, has entered the petrochemical industry, also in a big way, but in partnership with the

Distillers Company. Shell also illustrates what has been going on in a considerable number of the large oil companies in recent years in other countries.

CHEMICAL FIRMS IN GREAT BRITAIN

I have shown by the two case-histories of I.C.I. and the Shell Group how large-scale chemical industries have arisen in this country. There have, of course, been other methods of entry. Courtauld's, whose original interests were in silk textiles, entered via the rayon industry, which utilizes chemicals on a considerable scale, and they have now extended their interests into the man-made fibre field and into other chemicals. Distillers, on the other hand, came in via fermentation and the manufacture of alcohol for industrial purposes.

Another method of entry which has become intensified in recent years, is by large-scale U.S.A. chemical concerns undertaking manufacture in the United Kingdom via a subsidiary or with a partner. Monsanto is one example and du Pont's recent move into Northern Ireland is another.

It must not be imagined, however, that the chemical industry in the United Kingdom is all large-scale. Whilst a number of individual firms produce a wide range of chemicals, there are nevertheless a considerable number which concentrate on one, or a few, products and there are many efficient small firms. Let us hope that this will continue, for there are virtues and advantages in small-scale organizations as there are in large-scale ones. The spheres in which they are most valuable are nevertheless different, and it is inevitable that the tendency to larger organizations will continue.

As Bernal wrote,[5] 'The general development, both of science and industry, leads inevitably to ever more intricate forms of organization; our task is not to resist this tendency, but to understand it and see to it that what organization is necessary is used effectively and for good ends.'

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DISCUSSION

DR. E. A. G. LIDDIARD (Fulmer Research Institute): I should like to ask a question which I hope will not be taken as being political; it is not supposed to be political. I was interested to hear Dr. Taylor's account of the part the Government played in the initiation of Imperial Chemical Industries just after the Kaiser's War. What in the lecturer's view is the function of the Government in stimulating and starting, and to what extent in continuing, new industry, such as the chemical industry?

THE LECTURER: This is a very wide question, and it is rather out of the line of the subject about which I have been talking.

I should like to correct, first of all, your statement about the Government in relation to I.C.I. As far as I know, the Government had no part in the formation of I.C.I., but had a part in the initiation of experimental work on the Haber-Bosch process. It was, more or less, an accident that one of the constituent companies of the

merger had taken up that process previously. I do not think we can deduce anything from that as to the part the Government should play in the formation of industries. However, it is quite clear that during war the Government must harness national resources in what it thinks is the best fashion. Consequently, during wartime there must be a great technological urge which can be introduced into industrial activities for peace purposes after the war. Again and again scientific activities which have taken place under the impetus of war have been utilized afterwards for peaceful purposes.

In respect of the peace-time action of the Government, I should not like to express any definite view about the part they should take in industry. However, I am quite certain that they should take a very definite and generous part in education, particularly in producing all grades of the population capable of living satisfactorily in a technologically-based society.

I am afraid I have not answered your question in full, but I have answered portions of it.

THE CHAIRMAN: I think it is difficult to answer that question. Possibly Dr. Liddiard was thinking of the Government action in instituting further dyestuff production in the country through the formation of the British Dyestuffs Corporation. That was before the formation of I.C.I.

MISS M. G. MANN: Dr. Taylor referred to Shell Haven, the separation of gas and refrigeration. Does it refer to the methane which comes from Venezuela?

THE LECTURER: If I recall the slide accurately, I was referring to all the gases which are produced at that time, like ethylene and the various other gases in that process which are frozen out or cooled out.

DR. H. J. BARBER (May & Baker Ltd.): Coal, which is a very common complex organic chemical, has not been referred to as yet. Do you foresee any major advance in the use of coal as a source of chemical products, with its possibly declining use as a fuel?

THE LECTURER: I am afraid that I cannot really answer that question. I believe that everyone thinks and feels that when we have coal which can be dug out of our own backyard it should be capable of utilization for the production of power and as a source of chemicals. However, I am afraid we are in a stage of development at the present time where the production and selling costs of oil are very much lower than those of coal. Oil can be transported easily and used easily. In the present circumstances there is no doubt at all that the chemical industry throughout the whole world is turning more and more to the use of oil. The chemicals produced from coal are by-products of other industries. It is probably a state of affairs which is disadvantageous to us—it appears to be so. I personally do not know enough about the coal industry, except the blasting of it, to be able to give you an opinion as to whether that tendency will be reversed.

THE CHAIRMAN: I should just like to say how grateful I am to Dr. Taylor for his considering the possibly wider definition of 'chemical industry'. I think this will be important in the future.

I may say that I listened, as I am sure you all did, with entranced interest to the history which he has unfolded. The only time, if I may be permitted to speak on a slightly less serious note, I did disagree with him was when he made what appeared to be a slightly deprecatory reference to an old friend of mine when he was praising other people, and when he added—'and even (Ivan) Levinstein'. I understood it when I recalled that many years ago a maidservant complained that the Vicar had not included the Prince of Wales in his prayers. She was sure that he distinctly said, 'All but (Albert) Edward, Prince of Wales'.

I should now like to be a little more relevant and to say how very valuable this lecture has been, particularly so in the choice of I.C.I. and the Royal Dutch/Shell Group, because one thing which is quite essential in the chemical industry at present is a very large organization at your back. For safe development a considerable buffer capacity is necessary—and by that I mean financial buffer capacity—since accidents do occur. An example is the case of the firm which was started in Manchester after the removal of the duty on light hydrocarbons to be used for chemical purposes, Petrochemicals. That was a contribution to the nation's chemical industry courageously given by the Finance Corporation for Industry. However, it was obvious that even they, with their great resources, were not sufficiently insensitive to shocks, and it was a great thing for 'Petrochemicals' when it was acquired by the Royal Dutch/Shell.

We are greatly in your debt, Dr. Taylor, and we do wish to thank you very warmly for the two brilliant lectures which you have given, and particularly at this moment for that which we have just heard.

A vote of thanks to the Lecturer was carried with acclamation and, another having been accorded to the Chairman upon the proposal of Mr. Oswald P. Milne, the meeting then ended.

III. THE MODERN CHEMICAL INDUSTRY IN GREAT BRITAIN

delivered on Monday, 6th February, 1961, with Sir Alexander Fleck, K.B.E., F.R.S., President, Society of Chemical Industry, in the Chair

THE CHAIRMAN: Dr. Taylor has already talked of the philosophy of the industry and he has also dealt with the springs of progress. Those of us who have been in the chemical industry, as I have for the last forty or more years, know that these two factors have indeed produced a great change in the industry. In the early days, I think it would be a fairly correct picture to describe the industry as crude chemistry and even cruder engineering, but once physical chemistry took control, once physical chemistry came into the industrial picture, then the whole energy concept cleared things up and we moved toward a very much better and more regulated industry.

So tonight Dr. Taylor is going to speak on the modern chemical industry. His approach after the two previous lectures will be, I am sure, essentially a pragmatical approach, and in the light of the two previous lectures I am certain that is the correct and interesting way to deal with the subject.

The lecture, which was illustrated with lantern slides, was then delivered.

THE LECTURE

INTRODUCTION

In my first lecture I described the characteristics of the modern chemical industry and in the second lecture the development during the present century. In my lecture to-day I shall be concerned with the present and future state of the industry, its composition and statistics: the contribution it makes to the national prosperity. Quite apart from the direct contribution to our well-being by the production of fertilizers, dyestuffs, plastics, paints, medicinals and man-made fibres for our own use, the industry is vitally important because of its exports. It is now third in importance in our list of exporters.

Some statistics for typical chemical products are set out in Table I (p. 368). In the last twenty-three years production of sulphuric acid, which is usually considered to be a good overall trade indicator, has increased by over $2\frac{1}{4}$ times, plastics by over $2\frac{1}{2}$, fertilizers by nearly 3 times and man-made fibres by over $3\frac{1}{2}$ times. The overall rate of increase of production in chemical products is round $5\frac{1}{2}$ per cent per annum, which is twice that for manufacturing industry as a whole. The British chemical industry is growing at about the same per cent rate as the American industry, but it is about one-fifth the size of it.

The gross fixed capital formation since 1949 is shown in Table II (p. 369). The annual rate of capital expenditure has risen from about £64 million in 1949 (corrected to 1959 prices) to £163 million in 1958. There was a temporary set-back in 1959 due to credit restrictions, but the position appears to have recovered. The current figure equals about 17 per cent of the total expenditure in all manufacturing industries. Total capital invested in fixed assets in the chemical industry is reliably believed to be in excess of £2,000 million.

TABLE I

UNITED KINGDOM PRODUCTION OF CHEMICAL PRODUCTS

Sulphuric acid (as 100% acid)	'000 *tons*	1935	—	936·0
		1938	—	994·8
		1948	—	1,552·3
		1958	—	2,241·1
Man-made fibres	*Million lbs.*	1935	—	118·8
		1938	—	134·6
		1948	—	233·9
		1958	—	422·2
Calcium carbide	'000 *tons*	1941	—	3·0
		1948	—	92·1
		1958	—	144·9
		Years ended 30th June		
Nitrogenous fertilizers (Nitrogen content)	'000 *tons*	1940	—	123·4
		1948	—	229·1
		1958	—	341·5
(Covers ammonium sulphate, 'Nitro-chalk' and concentrated complete fertilizers.)				
Plastic materials	'000 *tons*	1950	—	155·0
		1958	—	416·8
(Covers net sales, 1950 figure is estimated.)				
Synthetic dyestuffs	'000 *tons*	1951	—	34·8
		1958	—	24·1

Source: Annual Abstract of Statistics, 1960
(*By permission of the Controller, H.M. Stationery Office*)

The industry is backed by a high rate of expenditure on research and development which, by and large, has been very successful and has led to much technical innovation, providing attractive possibilities for new investment. In 1958 the expenditure on research and development was no less than £22 million and was equal to 10 per cent of the total sum expended for all manufacturing industry.

The technological nature of the industry requires the employment of many scientists and technicians, at the present time over 11,000. Table III shows the breakdown as between chemists, physicists and engineers, for the years 1956 and 1959.

The number of people employed in the chemical and allied industries has increased from about 200,000 in 1935 to nearly 400,000 in 1957, but this is no indication of the progress of the industry, since more and more mechanized and automatically-controlled plants, employing fewer people to obtain the same or

TABLE II

GROSS FIXED CAPITAL FORMATION AT 1959 PRICES

	£ mn.
1949	64
1950	84
1951	100
1952	99
1953	110
1954	114
1955	117
1956	151
1957	158
1958	163
1959	126

greater production, are being erected. In fact, during the same period the value of gross output has increased from about £200 million to £1,700 million. Exports in 1957 had risen to 265 per cent of the 1948 level and are currently round about £290 million per annum. This is about 10 per cent of the total exports and no less than 28 per cent of it goes to Western Europe.

TABLE III

QUALIFIED SCIENTISTS AND ENGINEERS EMPLOYED IN THE UNITED KINGDOM CHEMICAL INDUSTRY, 1956 AND 1959

	1956	1959
Chemists	5,464	7,697
Physicists	248	481
Engineers	2,301	3,225
Total ...	8,013	11,403

N.B. These figures relate to the Chemicals and Allied Trades (Order IV (a) of the Standard Industrial Classification). They exclude Mineral Oil Refining.

NATURE OF THE INDUSTRY

The chemical and allied industries in Britain are heterogeneous and, although many of their activities require large resources, as I stated in my last lecture, there is still room for the small, but efficient, specialist. Thus, according to the 1954 census of production, of 3,255 firms employing in total 338,000 people, there were 1,424 with less than 11 employees, 1,773 with between 11 and 1,000 employees, and 58 with more than 1,000. The large firms (over 1,000 employees)

account for about 38 per cent of the gross output, of the net output and of the employment.

Table IV lists the larger United Kingdom chemical companies and the main products which they manufacture. The companies are given in order of size as judged by the trading profits (1959). The list excludes the oil companies because their activities are only partly concerned with chemicals and are not readily separable.

TABLE IV

THE LARGER UNITED KINGDOM CHEMICAL COMPANIES

Company	*Order of Size 1959 Trading Profit Basis*	*Actual Trading Profit —1959 £000's*	*Product Groups*
I.C.I.	1	121,257	Organic and inorganic chemicals, dyestuffs, pharmaceuticals, fertilizers, explosives
Distillers	2	27,100	Fine chemicals, P.C. products,* distillation products
British Oxygen Co. ...	3	14,329	Welding and industrial gases
Boots Pure Drug Co.	4	8,009	Heavy chemicals, pharmaceuticals, medicinals, P.C. products*
Albright & Wilson ...	5	6,940	Heavy chemicals, fats and greases, P.C. products*
Glaxo	6	6,582	Pharmaceuticals
Borax (Holdings) ...	7	5,569	Heavy chemicals, rare earths
Fisons	8	5,312	Sulphuric acid, fertilizers
Monsanto	9	4,525	Plastics, acids, pharmaceuticals
Laporte	10	2,860	Heavy chemicals, soap powders, detergents, borium compounds
De La Rue	11	1,945	Plastics
W. J. Bush	12	1,030	Aromatics, dyestuffs, intermediates
British Glues & Chemicals	13	822	Glues and greases, fertilizers, animal foods
F. W. Berk & Co. ...	14	750	Heavy chemicals, medicinals, pharmaceuticals
Reichhold	15	723	Synthetic resins and resin compounds
Hickson & Welch ...	16	702	Dyestuffs and intermediates, P.C. products*
Boake Roberts & Co. (Holdings)	17	387	Heavy chemicals, pharmaceuticals, plasticizers, fats and greases
Wm. Blythe & Co. ...	18	374	Heavy chemicals, medicinals, pharmaceuticals
L. B. Holliday ...	19	341	Dyestuffs
Hardman & Holden	20	309	Heavy chemicals, fats, greases
Lawes Chemical Co.	21	141	Chemical fertilizers
Howard & Sons † (1958)	22	135	Organic chemicals, plasticizers

Source—Moodies Sheets * Pest Control Products † Data for 1959 not available

TABLE V

THE LARGER AMERICAN AND EUROPEAN CHEMICAL COMPANIES

Company	*Order of Size* 1959		*Sales* 1959 $ *Millions*	*Employees* 1959 000's
	Sales Basis	*Employees Basis*		
Du Pont (U.S.A.)	1	2	2,114	85
Union Carbide (U.S.A.)	2	4	1,531	59
Imperial Chemical Industries (U.K.)	3	1	1,424	110
Borden Co. (U.S.A.)	4	10	941	32
Allied Chemical Co. (U.S.A.) ...	5	11	720	30
Dow Chemical Co. (U.S.A.) ...	6	13	705	27
Olin Mathieson (U.S.A.)	7	9	702	38
Monsanto Chemical Co. (U.S.A.) ...	8	18	615	19
Farbenfabriken Bayer (Germany) ...	9	5	585	55
American Cyanamid (U.S.A.) ...	10	12	584	29
B.A.S.F. (Germany)	11	6	540	53
Farbwerke Hoechst (Germany) ...	12	7	529	45
Montecatini (Italy)	13	3	472	60
W. R. Grace (U.S.A.)	14	8	470	41
Kaiser Aluminium & Chemical Co. (U.S.A.)	15	16	436	20
Saint-Gobain (France)	16	17	395	20
Rhône-Poulenc (France)	17	20	304	15
Pechiney (France)	18	14	298	25
Hercules Powder Co. (U.S.A.) ...	19	23	284	11
CIBA (Switzerland)	20	15	235	21
Stauffer Chemical Co. (U.S.A.) ...	21	27	228	7
E. Merck (U.S.A.)	22	21	217	12
Rohm & Haas (U.S.A.)	23	19	216	17
Chemstrand Corporation (U.S.A.) ...	24	25	197	9
Glidden (U.S.A.)	25	28	196	6
Parke Davis (U.S.A.)	26	22	192	11
Thiokol Chemical Co. (U.S.A.) ...	27	24	190	10
Hooker Chemical Corporation (U.S.A.)	28	33	150	5
Diamond Alkali Co. (U.S.A.) ...	29	30	138	5
Abbott Laboratories (U.S.A.) ...	30	26	123	9
Interchemical Company (U.S.A.) ...	31	32	123	5
Vick Chemical Company (U.S.A.)	32	31	115	5
Wyandotte Chemicals (U.S.A.) ...	33	34	94	4
Reichhold Chemicals (U.S.A.) ...	34	38	94	2
American Agricultural Chemicals (U.S.A.)	35	35	91	4
Pennsalt Chemicals (U.S.A.) ...	36	36	88	3
Schering Inc. (U.S.A.)	37	29	81	6
Miles Laboratories (U.S.A.) ...	38	37	72	3

Source—The *Fortune Directory* of the 500 largest U.S. Industrial Corporations, and the 100 largest Foreign Industrial Corporations.

In order to compare United Kingdom with other countries, Table V (p. 371) displays the larger companies in the western world. It will be seen that of the 38 companies given in rough order of size, I.C.I. is the only United Kingdom company which comes into the list. (Again the oil companies are not included.) There are several other European companies which might rank for inclusion, but because of the absence of the relevant data they have had to be excluded. These are Norsk Hydro (Norway), Bombrini Parodi-Delfino (Italy), Ugine (France), Solvay (Belgium) and Kuhlmann (France).

PRESENT TRENDS IN CAPITAL INVESTMENT

In order to get some idea of what developments there are likely to be in the next few years it is useful to examine projects for new and extended plants which are being undertaken; in other words, to examine the present trends in capital investment.

A survey published last year in *Chemical Age* estimated that the total capital expenditure sanctioned, completed or put in hand during 1960, was nearly £200 million. Since the survey was issued there have been other announcements and the actual total is probably £220 million or more.

The survey includes 106 firms and embraces undertakings of a wide range of size and activities. One hundred and ninety projects are specified, and although some are relatively small, the number is impressive. Not all the plants are for use by the chemical industry proper.

In the inorganic field there are no less than eight projects for the work-horse sulphuric acid. A part of this expenditure relates directly to the fertilizer industry. It is to be presumed that the requirements for sulphuric acid, which have shown a growth of about 4·3 per cent per annum over the last two decades, have caught up with the surplus capacity which has been available in recent years.

There are two modest increases for the other work-horses chlorine and caustic soda. Again, it would appear that these are to take care of the normal rise in demand. There are six projects for manufacturing fertilizers which reflect the growing demand for compound and concentrated fertilizers, as well as for the older products.

A notable feature is the installation of large high-pressure catalytic reforming plants and of Lurgi plants, by the Gas Boards. This represents the application of the new type of chemical processes to the gas industry to produce fuel gases instead of gases for synthesizing chemicals. It is also worthy of remark that the Lurgi high-pressure coal-gasification plant uses oxygen instead of air to oxidize the coal or fuel and thus produces high-calorific value gas, not diluted with atmospheric nitrogen. Tonnage oxygen plants have made this possible and nine (perhaps ten) oxygen plants are involved in the various projects, not only for gas production but for steel-making. The techniques of preparing oxygen cheaply in bulk have triggered off a number of important advances in industrial chemistry and metallurgy.

No less than 27 projects are directly concerned with petrochemicals, and account for a high proportion of the total expenditure. Plants for the manufacture of high-polymeric compounds, for resins, plastics and rubber-like materials are particularly prominent for, in addition to the petrochemical projects which are to a large extent

concerned with producing gases for further polymerization in the form of polyolefines, there are plants for nylon and other polyamide yarns, for neoprene, Courtelle acrylic fibre, melamine, polystyrene, acrylonitrile, Perspex, synthetic rubber, silicones and p.v.c. Indeed, there are no less than 31 projects concerned with polymeric materials.

It would appear from this analysis that at the present time the chemical industry is expanding sufficiently to keep pace with the increasing demand for the basic heavy chemicals of the industry and for the rising requirements of fertilizers. In addition, it is exploiting new techniques, such as the use of bulk oxygen, instead of air. Primarily, however, it is developing rapidly in the field of petrochemicals, fulfilling the growing demands for all sorts of polymeric substances for the plastics and man-made fibre industries.

TABLE VI

THE CHEMICAL INDUSTRY

Gross Output Value, 1954—£765 *million*

	£ million	%
Man-made fibres	102	13
Synthetic resins and plastic materials	83	11
Synthetic rubbers	—	—
Synthetic detergents	31	4
Fertilizers and pesticides	80	10
Dyestuffs	60	8
Explosives (and fireworks)	53	7
Coal tar products	30	4
Heavy inorganic chemicals and heavy organic chemicals (including intermediates)	326	43
	£765	100

The pattern of progress has also been well illustrated by Mumford[1] working on the data of the 1954 Census of Production and making various corrections for the 'Allied Industries'. Table VI shows output figures for chemicals in the various categories, including man-made fibres. The table illustrates clearly the growing importance of fibres, plastics, rubbers, synthetic detergents and fertilizers, of types which were practically unknown at the turn of the century, and even much later.

THE FUTURE OF THE CHEMICAL INDUSTRY

Organization

The economic forces which promoted the formation of large companies after the First World War, which we considered in Lecture II, continue to operate, but there are many others acting in the same direction.

For a number of reasons chemical companies are becoming more international. Economic nationalism which has intensified in recent years has resulted in chemical plants being erected in many countries by foreign capital, and there is also a movement, not particularly strong to date but growing in impetus, to manufacture chemicals where the raw materials of manufacture are advantageously available. For example, some petrochemical plants are located at selected sites where olefine gas streams are cheaply available.

Only large companies can support world-wide manufacturing and selling organizations, and the growth of international activities thus tends to favour the large company.

The recent formation of the European Economic Community must also have a profound effect on the chemical industry. Many companies are now considering possible manufacture in E.E.C. in order, as Sir Alexander Fleck remarked 'to serve a compact highly industrialized market with relatively high purchasing power and consisting of some 250 million people . . . a market comparable to that of the largest, richest and most sophisticated buying public in the world—the United States domestic market'.[2]

As a result the chemical industry is likely to become more international in character than it has been hitherto, and be organized into larger concerns.

In Britain the provisions of the Restrictive Practices Act may tend to drive inefficient firms out of business and promote the aggregation of small units into larger ones which can be reasonably self-sufficient and possess adequate resources.

Many factors operate to produce monopolies (by statutory definition an organization which commands 33⅓ per cent or more of the trade). This tendency is likely to continue and perhaps intensify.

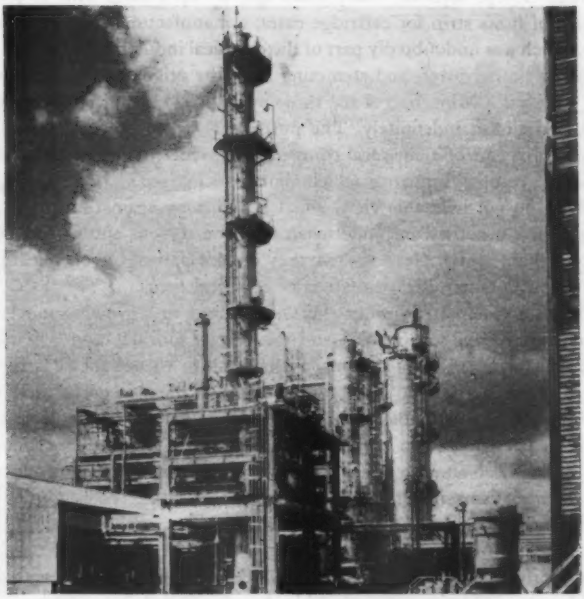
I do not believe that monopolies, as such, are objectionable. Nor does the law presume that monopolies are bad; it provides machinery for inquiring into possible abuse of monopoly power, but only if, after prolonged and careful investigation, such abuse is shown to exist does the question of remedial action arise.

Reddaway[3] in relation to the British chemical industry wrote recently, 'one of the advantages of having production largely in the hands of a few very big firms is that they assume a sense of responsibility to the public interest which is probably more valuable than any formal regulations or agreements could be in such a complex and changing industry. Moreover, there are a number of checks and balances in the industry which make unduly restrictive practices hard to maintain.'

It is too often assumed that unbridled competition promotes healthy industry and is essentially good. What in fact often happens where such conditions operate is that profits are insufficient to allow for re-equipment and innovation in the industry, and there is no margin for research and development activities which are so essential if industry is to make any progress and meet outside competition.

It is clearly inefficient and wasteful from the national point of view to have a number of similar firms duplicating research, development and sales organizations and erecting at great cost similar plants, often not fully occupied, and cutting one another's throats even in the export trade.

I believe in competition. It is essential for progress and efficiency, but it is



[*Shell Photograph*

FIGURE 1. *Illustrating modern chemical plant—an atmospheric distillation unit at Carrington works*

nonsense to suppose that inefficiency arises from monopoly *per se*. Indeed, a monopoly position may develop because of a firm's efficiency and not because it has consciously sought that position. Since competition stems from the urge to survive it will arise if not in one form, then in another. In the chemical industry, for example, international competition is becoming increasingly severe and British industry will only be fit to meet it with large efficient organizations. There are, of course, the seeds of retrogression and decay in any large organization, but they exist too in smaller organizations. It is not only the elephant which grows old and dies. Many smaller animals have much shorter life cycles.

Diversification

I mentioned in my first lecture that chemical firms include activities which are not part of the chemical industry.

For example, Imperial Chemical Industries has a Metals Division, mainly concerned with wrought-metal products which, even in the case of the newer metals, cannot be regarded as chemical.

Such an anomaly is readily explained as an historical accident. Kynochs (now the Metals Division of I.C.I.) were part of the Nobel Industries when the I.C.I. merger

was formed. George Kynoch, many years ago, set up a Strip Mill to provide his own source of brass strip for cartridge cases, a manufacture within the explosives industry, which was undoubtedly part of the chemical industry. For similar reasons, I.C.I. has a printing press, and stemming from the original entry into the metals trade, it even has a Mint, one of the three in Britain. Examples of this sort could be multiplied almost indefinitely. The purist may argue that such manufactures should not form part of a chemical company's activities, that they divert the main effort and are vestigial remnants which should be excised by the surgeon's knife. Personally, I do not hold this view, and I see nothing against ancillary activities and diversification if they are undertaken for good reasons and can be continued profitably and efficiently. Nevertheless, they are not part of the chemical industry, merely ancillary or peripheral activities of chemical firms.

Apart from accidental inclusions there is a strong and growing movement for modern chemical firms to diversify, and this merits consideration. Diversification is undertaken for a variety of reasons. Firms wish to ensure the security of their supplies of raw materials and this prompts some of them to go further back into the manufacture of intermediates and basic chemicals. For example, a company may erect an Oil Cracker to secure supplies of gases for further chemical processing. There is also an urge to have 'captive' outlets for chemical products which has led chemical firms into the paints, plastics fabricating, packaging and textile industries. As the chemical industry evolves and as applied chemical science widens its scope, this trend will intensify.

Since modern society is as much or more concerned with 'effects' as with chemical compounds, the industry will inevitably be channelled into producing these. As quantitative chemistry extends so will the bounds of the chemical industry expand to obtain new qualities and effects in materials to fulfil current and future demands. In addition, new uses, probably quite novel and unforeseen, will be established for modified materials. This will result in further diversification of the industry.

Future Developments

Mumford[1] has considered the future pattern of the chemical industry. He examined, as I described earlier in this lecture, the present pattern and quantity productions of the industry and extrapolated the data to provide estimates for the growth over the next ten years, both in the organic and inorganic sections. He concludes that by 1970 the total production of synthetic fibres may be 420,000 tons, which is nearly double that of to-day, and prognosticates that the output of resins and plastic materials may be around the 1¼ million tons in 1970, compared with about ½ million at present.

Mumford sums up with the view that, over the next ten years, total production of organic chemicals is likely to increase about 2½ fold and inorganic chemicals by about 40 per cent.

Polypropylene may well play a great part in this expansion, both as a film and as a fibre-forming material. The production of foamed plastics and synthetic rubbers is likely to increase very substantially. Synthetic detergents will also be required in greatly increased quantities.

FIGURE 2. *Illustrating modern chemical plant—a view of part of the Wilton works, showing how pipe-lines and services are now laid in ditches instead of on overhead pipe-lines as in the* 1930*s*

There are additionally certain specialist chemical products worthy of special mention. The requirements for the newer metals and for materials of a purity previously unparalleled for specialist applications, as in transistors, are likely to increase considerably. So far I have not mentioned photographic chemicals. Important advances have been made in colour photography in recent years and this business is certain to increase because of the great and rising public demand. I ought also to mention rocket fuels. Having worked over a considerable period on such substances I have a hunch that in due course they will become substantial business.

At this stage, since we are considering future developments, I would like to make a few further remarks about fibres and plastics. The attitude of the public towards synthetic materials and effects determines the trends of demand. Hitherto, the public has looked to natural materials, such as leather, wood, furs, wool and such-like, as providing the standard of excellence, and synthetics have been regarded as poor substitutes or *ersatz*, to use a German term, which acquired a rather sinister significance. Synthetics, in the first place, were designed to imitate natural products.

Thus, plastic-coated cloth was called 'leathercloth' and was designed to imitate hide. The position is changing rapidly. The change started when synthetics showed properties which were clearly superior to those of natural products. Thus, polythene film is definitely superior to a pig's bladder and so is nylon filament to catgut. Sheer nylons are superior (from the woman's point of view, I mean) to any silk stockings that I can remember. As the public comes to accept synthetics in their own right and as art exploits them as media of merit—not as substitutes—there will be a great increase in the demand for a wide and increasing range of high polymeric substances.

I may be permitted to quote one possible example. Natural fibres are produced in enormous quantities, far exceeding those of the man-made fibres. The whole textile trade is based on the development of the use of natural staple fibres over thousands of years, and to-day man-made fibres, to a very great extent, are forced to conform to tradition. There are, nevertheless, great possibilities of revolutionizing our clothing by use of continuous filament, of non-woven fabrics and of synthetic foam sheeting, once we are conditioned to accept non-traditional textiles.

I should now like to say a few words about the fermentation industries. In my first lecture I tried to discern a philosophy of the modern chemical industry and came to the view that it is primarily concerned with manufacturing chemical compounds by synthetic routes which can only be established through quantitative chemical science. Notwithstanding, though I was prepared to exclude the traditional fermentation industries from the modern chemical industry, I do not believe that we can exclude the newer fermentation industries which are producing such products as penicillin, streptomycin, and so on. The chemist in these industries, for lack of alternative routes, is using microbiochemical methods of preparation, but he is applying to the separation and analysis of the products chemical techniques of the highest order. These industries, like their predecessors, must go through a transition stage, but they are vital parts of the growing chemical industry and are gradually being quantified.

There have been considerable advances in the pharmaceutical chemical industry in recent years and progress is likely to continue at an accelerated rate as medical chemical science advances. In the fields of biochemistry and biosynthesis we are in the early stages of new and exciting developments, and in the not too distant future it is certain that these will be exploited on the industrial scale.

The chemical industry is vitally concerned with the enormous potentiality of nuclear energy applications and the promise of vast sources of energy for the use of mankind. All present trends indicate that the nuclear energy industry will become a major one. This will be accompanied by a considerable expansion in chemical industry designed to serve it. One can envisage a time when the preparation of nuclear fuels and elements may become a great chemical industry with considerable demands for new metals, for new materials of construction, and for ultra-pure elements and compounds.

I have a feeling that in the case of nuclear energy, as in so many previous historical cases, developments made under the duress and fear of war, will ultimately be used for the great benefit of mankind. That certainly must be our hope.

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2. *Chemistry and Industry*, 3rd October, 1959, p. 1239.
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DISCUSSION

THE CHAIRMAN: Dr. Taylor has opened his flank by being so bold as to have a look into the future and spurn profit just for a relatively short time. I feel sure that some members of the audience would like to question him on the basis of his prophecies.

MR. M. C. HYDE: Dr. Taylor spoke of the future for rocket fuels. Does he see that in the solid form or the liquid form?

THE LECTURER: That is a queer question to put to me. I must declare my interest; I have always worked on solid fuels. Of course, I think there is a future for both of them. I believe that particularly solid fuels will be used for boosts and for certain sustainer rockets, but for larger sustainer rockets I should think there is a very big future for liquid fuels.

So, on the whole, I would say there is a considerable future for both types. We are in some difficulty at the present time, as you know, in that it looks as if quite a lot of interesting new fuels are possible but they have not yet been worked out: no doubt some of those will be solid but quite a lot will be liquid.

MR. G. F. UNDERHAY: I was interested in Dr. Taylor's rather quick reference to synthetic foam sheeting as possibly providing a part of our clothing requirements in the future. Would he elaborate just a little on that?

THE LECTURER: I think, if I dared, I would go round in synthetic foam sheeting covered with aluminium foil! That would probably be one of the best types of clothing one could have; but as I indicated in my lecture, it is going to be a long time before anybody will accept that sort of thing.

The other thing I had in mind, of course, was that either by foaming materials or by using non-woven fabrics one will ultimately be able to get the sort of characteristics which one has had hitherto in woven fabrics. I cannot believe that this is out of the realm of possibility.

Also, if one looks at the clothing habits of some of the younger generation—particularly in the region of Chelsea where I happen to live—one sees that they have not the same reluctance to wear synthetics (even if they do not look like natural materials) which some of us who are much more conservative have. Once that is accepted, I am quite sure that one can produce the necessary type of insulation, circulation of air, and so on, which is needed for clothing and, of course, reflection of heat waves, and so on, if one wishes to have it.

MR. G. F. UNDERHAY: The aluminium would give a nice permanent crease in the trousers at least!

MISS D. L. MERMIKIDES (British Sulphur Corporation): In your statistical data you quote figures for 1954 and you have referred to Mr. Mumford who, I think, is from I.C.I. as well. Do you find difficulty in obtaining statistical information to forecast trends?

THE LECTURER: Referring to those particular figures, I think the 1954 ones were the latest complete range of figures which were available when I was writing this lecture towards the end of last year. However, there are many figures subsequent to that in individual cases and one can get them if one goes into sufficient detail.

In so far as this lecture is concerned, it was not written to appeal to real specialists inside the industry, but rather—as I hoped anyhow—to appeal to people who were interested in 'arts' in the old definition of that word. Therefore I did not perhaps go so closely into obtaining more recent statistics as would have been necessary if my object had been other than merely to indicate trends for an audience of this description.

However, taking your question generally, I would say that it is difficult to obtain statistics, but if one takes sufficient pains one can find adequate statistics to guide one on any particular exercise.

MISS S. A. MANN: Referring to your table on the larger United Kingdom chemical companies: at a recent schoolmasters' convention at which I.C.I. were joint hosts with a number of other companies, a speaker from Courtaulds mentioned that they placed themselves as the fourth largest company. Could you comment on this and on the table in general?

THE LECTURER: This particular table is got out in a specific way. As it says in the text, it is based upon the actual trading profit in 1959, and in that sense, of course, one might get a completely different result if one took the total value of capital assets, for example, or the total number of people employed.

DR. I. BERKOVITCH: Since the end of the war, the chemical industry has been one of the most remarkable growth industries in all industrial countries; in fact, I think that it has been one of the two most consistent in growth—the other being the electronics industry. This feature is not true of the pattern before the last war. Mumford quotes an annual growth rate of 2½ per cent per annum for 1901-38, and 6 per cent per annum for 1948-58. Would you comment on this marked difference?

THE LECTURER: I have not got the figures in front of me, but I have it in my mind that this trend started after the First World War when this country really had to face the production of its own dyestuffs and all sorts of organic chemicals for which it had previously depended on Germany. Of course, during the war, as I pointed out in my second lecture, I believe, we found that we *had* so depended on other countries—we found out the hard way—and we began to take steps to rectify that. However, my view would be that, although the trend began then, it took quite a number of years to build up the people of sufficient technical knowledge in the industry required to carry out increases of the sort which now characterize the chemical industry. So I would think this trend started from the First World War, increased during the inter-war period and then had an enormous increase largely due to petrochemical activities after the Second World War; although these chemicals were just established and beginning to make an impact before the Second World War, their big increase occurred afterwards.

MR. OSWALD P. MILNE (Chairman of Council of the Society): Before we let Dr. Taylor go, I should like to ask him why he feels that to be clothed in aluminium foil would be such an ideal arrangement. It seems to me that it might look very fine—rather like a medieval knight in armour—but does he think that with these synthetic materials our clothes would be more comfortable, or would wear better? For what reason does he suggest that in a few years we shall all be wearing synthetic fibres instead of natural wools?

THE LECTURER: In the first place, of course, a considerable number of members of one sex are wearing man-made fibres at the present time and that is increasing enormously. I think the whole population will follow in that trend. The reason why I say that I believe synthetics will replace these natural materials is that ultimately, by scientific command of the properties of these materials, we shall be able to achieve effects such as insulation, comfort and appearance, which just cannot be got by natural materials. You have to take natural materials more or less as they occur and there is a limit to what you can do with them, whereas synthetic materials can be fashioned in a manner which—provided you know enough about the chemistry—is completely under the control of the technologists.

With regard to aluminium—one is usually told on television that there is no advertising—I happen to make aluminium foil so I am interested in it. That is why it came to my mind, but a metallic foil like that has very good properties for reflecting heat rays, and therefore, used in certain ways, it can keep the interior which it clothes comfortable, in the case of either circumambient heat or circumambient cold.

MR. E. G. HANCOCK (Shell Chemical Co. Ltd.): I wonder if I might return to that table of trading profits again. I was interested in the Distillers' Co.'s figure. Did Dr. Taylor manage to disentangle their chemical interests from all their other interests?

THE LECTURER: I think there is some doubt about that. It was done to the best of our ability, but I am afraid in a lot of these figures there must be a doubt of that sort.

THE CHAIRMAN: Before I bring the meeting to a conclusion, I should just like to ask Dr. Taylor one question. As I listened to him I found him restating the philosophy which we heard very frequently in the late 1920s: the philosophy of the then rationalization of industry. As I say, I think he restated it, with some slight modifications and additions, but they were only slight, and to my mind, not basic.

I should like to ask Dr. Taylor if, with the experience he has had over the last thirty or even more years, he thinks the philosophy of rationalization which we knew in the late 1920s has stood the test of time and requires very little modification to meet the present-day circumstances.

THE LECTURER: Sir Alexander, I think you are quite right. In my second lecture I quoted from the letter which was issued by the four Chairmen of the companies which merged to form I.C.I., in which they gave their reasons for forming the merger; that was in 1926 and it hardly needs any alteration at the present day.

However, I do think there are additional reasons. Much more intensive international competition has now developed, and in this country too I think the Restrictive Practices Act gives another type of impetus which is bound to lead to these mergers.

In so far as the philosophy of the late 1920s and the 1930s refers to mergers, I agree with it and I do not see that we have much to alter, but if it refers to rationalization with centralization of all activities, then I feel we have to look closely at it. My view is that at the present time it is necessary for industry to be organized into specialist groups which have a complete command of their productive capacity, but the general policy should be under the command of a central group with a number of specialized functions provided by that centre. However, I do believe that perhaps the conception in the 1920s and 1930s did not allow as much delegation of authority, particularly in the financial and productive spheres, as appears to be necessary under present conditions.

THE CHAIRMAN: Dr. Taylor has given us a very thought-provoking lecture. I have already shown by the question I asked that I was very interested in his remarks about the development and organization of the industry. That is one aspect which is perennial in its interest, but when we come down to the practical aspects of this industry, it was really most encouraging and interesting to see from the figures which he gave us how sulphuric acid remains a very good marker for our rate of progress. If my memory is right—I am quite willing to be told that it is not—it was Disraeli who first of all pointed out that sulphuric acid was a very good measuring stick of the progress of this country. The figures which Dr. Taylor has given us show that to-day there is still something to be said at least for that fact and for that use of sulphuric acid as a measuring stick.

It is now my pleasure to ask you to express to Dr. Taylor your thanks for this series of lectures he has given. As I say, we are all interested in philosophy in our various ways; we are interested in progress, and we are interested in the actual state of the nation and of the industry. On that Dr. Taylor has given us a forecast of what he thinks as to the future. We thank him, not only for his interesting lectures but also for his boldness in predicting and looking into the future.

The vote of thanks to the Lecturer was carried with acclamation and, another having been accorded to the Chairman upon the proposal of Mr. Oswald P. Milne, the meeting then ended.

THE MYTH OF THE PHOENIX

A Dr. Mann Juvenile Lecture by

MAURICE BURTON, D.Sc.,

lately of the Natural History Museum

Friday, 30th December, 1960

The myth of the phoenix was first brought to Europe by Herodotus over 2,000 years ago. It centres around a bird said to appear from the East every 500 years, that settled in a palm grove and there built a nest. On an appointed day, and after due ceremony, it committed itself to the flames when its nest had been set on fire, and three days later was re-born from its own ashes. This is no more than a brief summary of the myth, which became greatly elaborated by the poets and philosophers of Ancient Greece and Rome.

A myth or a legend, no matter how preposterous or incredible in its final form, can usually be shown to have been started from a grain of truth. It was difficult to discover any such grain of truth in the phoenix legend until 1957, when a tame rook in my garden in Surrey was seen to behave in an extraordinary way over a heap of burning straw. To understand what happened then we need to recall another feature of bird behaviour.

On a number of occasions in the past a bird has been seen to pick up an ant in the bill and then assume a peculiar posture and go through unusual actions. It has spread its wings, either both wings at once or one wing at a time, with the primaries curving forward, twisted its tail to one side, and passed the head rapidly up and down under the wing on the same side to which the tail is twisted. When engaged on this unusual occupation, the bird looks as if it is rubbing the ant on the long wing-feathers. The whole action is rapid, and the posture such that the bird seems to have taken leave of its senses. It may, while so performing, topple over, even tread on its own tail and trip itself into a tumble.

Although anting has been observed in over 150 species of birds in all parts of the world, it is not a common sight. Not all individuals of these 150-odd species are known to ant. Indeed, it seems fairly certain that some are not given to it at all, others may indulge it on infrequent occasions, and just a few may become 'addicts' in being readily persuaded to ant at almost any time.

Not only is this behaviour unpredictable, it is also almost incomprehensible, and so far no satisfactory explanation has been put forward to account for it. The actions performed during the course of anting are nearly identical with those used in preening, but they are carried out more quickly and at a high intensity, the intensity being evidenced by an appearance of excitement, almost of ecstasy. There seems also to be a quality of infectiousness, for one bird anting may set others off.

The explanation for this behaviour which springs most readily to mind is that

it is a form of de-lousing, that the bird is using the acid secreted by the ants for dealing with vermin on the feathers. There are several good reasons for doubting this, one being that verminous birds seem less prone to anting than those that are relatively free of parasites. An even more telling argument against this theory is that in any community of birds of the same species, and all presumably of about the same standard of health and hygiene, a very few will ant regularly and others will be total abstainers.

Another argument against it is that the tendency to ant varies with the species. The common starling is very prone to it, and so are members of the crow family, especially rooks, jackdaws, jays and magpies. The robin redbreast, by contrast, has been seen to ant on very rare occasions only, while other members of the thrush family, including the song-thrush and blackbird, might be described as moderate anters.

It is not only ants that will stimulate a bird to ant, although these insects are most commonly used for the displays. Various birds have at different times been seen to adopt the characteristic posture and actions we speak of as anting when holding in the beak such diverse items as mothballs, lemon juice, apple peel, vinegar, aromatic berries, even sultanas and small moths. There have been individual birds known to ant with one or other of these substances yet never to ant with ants. And some have been seen to go through all the motions of anting under the stress of unusual excitement, and without any stimulant in the beak.

Another category of substances commonly used in anting, especially by members of the crow family, by starlings, parrots and budgerigars, are steam, warm water administered in the form of a fine spray on the breast feathers, smoke, hot ashes, burning cigarettes and lighted matches. Very rarely, almost as rarely as the phoenix is said to have put in an appearance, we come across a bird that will readily ant amid flames and will not ant with very much else: a bird for which fire seems to have an irresistible attraction. My tame rook is one of these.

When a heap of straw is lighted on the ground, this rook will come forward to it excitedly, will crouch over the flames, flap its wings over them and, apparently, snatch beaksful of flame or smoke and put these under its wings. Its posture while doing all this can best be described as spread-eagled, although the whole performance is far too animated to conform to the usual meaning of this term.

The performance not only appears fantastic to watch; there is the added remarkable feature that the bird appears to suffer no injury. The rook has performed in this manner on many scores of occasions and only once sustained slight harm, when it scorched a patch of the breast feathers no larger than a postage stamp. It is still alive and well, although it has been allowed to perform its 'fire-dance' for purposes of study, or to demonstrate to visitors, for the past four years.

As soon as the lighted straw is put on a platform, instead of on the ground, on a bird-table, for example, the posture used by the rook is that of typical anting. Both wings are spread, the tail is twisted to one side—or it may sometimes be fanned and brought forward under the body—the wings are flapped, the head put under one wing or turned to one side. The whole action is rapid and vigorous, the flames appear to be licking the plumage, and at times the rook is partially obscured

Niger the phoenix

by or enveloped in smoke. Although there is nothing static about the rook's performance on such occasions, one sees again and again, for brief moments, the typical picture of the phoenix.

The likeness to the traditional phoenix pictures of the western world is too strong to be ignored, but whether it represents the original idea behind the phoenix myth is another matter. Herodotus, in his first account of the myth, said nothing about fire. In Chinese pictures the phoenix is depicted with none of the accompanying flames. That part of the story is shown only in drawings dating from the post-classical times in Europe.

Despite this anomaly, there still seems to be a connection between the story as told by the later Greek and Latin writers and the way my rook behaves in the presence of fire. This prompted me to look for evidence elsewhere to fill in some of the gaps. There is the part of the traditional phoenix myth that tells of the nest in flames. None of the writers is definite as to the way the nest is set ablaze. Most of them take refuge in obscure allegory. It seems, however, that this part of the story, although seemingly so preposterous, might also be founded on good biological observation.

My search along this path started with a small news item in one of the provincial newspapers. This told of a fire in the roof of a house which was suspected by the fire officers who dealt with it to have been caused by a bird taking burning materials into its nest in the roof-space. I soon found on inquiry among news-reporters and

Close-up of Niger the phoenix

firemen that this was nothing new, and I have found since that several times each year this kind of report appears in various sections of the press. Furthermore, I learned from the fire service that it is by no means unknown for a tree, isolated from all other trees, standing alone in the middle of a stretch of grassland, to be ablaze in the upper half.

In the course of four years I have collected a number of examples of fires in thatched roofs that could be explained in no other way than by a bird having taken either a burning cigarette end or an ember from a garden bonfire into its nest. I have also had pointed out to me a yew in which a fire was discovered in the upper half of the tree. The yew is well away from human habitations and in a wood where few people go. Moreover, examination of the charred hollow showed the burnt remains of a jackdaw's nest.

Pliny tells of birds carrying lighted materials on to the thatched roofs in Rome and setting them on fire. Since then, there have been references in our literature to similar occurrences here in the thirteenth to sixteenth centuries. And I have numerous news-cuttings from other continents, notably from the U.S.A. and South Africa, of fires started in this way, or suspected of having been so started.

It seems not improbable, therefore, that birds anting with embers or cigarette stubs, even with fire, may be more common than we suppose. The occasions on which this is actually observed are, however, infrequent. From having watched

my own rook, and from having seen this fantastic display, it is easy to imagine that anyone centuries ago who happened to see a bird doing anything like this, sitting on a burning nest and apparently alive amid the flames, would have felt himself to be in the presence of a miracle. So even if there were some other origin to the myth of the phoenix, one can visualize this seemingly miraculous event being woven, perhaps with suitable distortions and exaggerations, into the general story.

Either that is a feasible explanation of part of the myth of the phoenix or we are in the presence of a most remarkable coincidence.

GENERAL NOTES

REYNOLDS, LANDSEER, AND THE THYSSEN COLLECTION

Of these three exhibitions of exceptional interest to Fellows, that devoted to Sir Joshua Reynolds, with whose labour for the independence of professional painters the early history of this Society is linked, may be judged of first importance. It is odd to reflect that the eighty-seven paintings from private and public collections assembled at the Birmingham City Art Gallery were the first considerable representation of Reynolds' work since 1937, and one could wish it had been extended beyond 19th March. 'Damn him, how various he is!' exclaimed Gainsborough once of the Royal Academy's first President. It is rather Reynold's *variableness*—the obvious uncertainties of his more strenuous compositions in the grand manner, and the unhappy effect of time on the elaborate cookery of his pigments—which has somewhat depreciated his reputation, at least in this century. But while it is undeniable (as Roger Fry observed) that Reynolds 'frequently announces a masterpiece and fails to substantiate the claim', it has also to be said that his vein of unstrained naturalism can be most beautifully reconciled to studious design in portraits whose freshness and charm have a positively nineteenth-century air, without any hint of Victorian sentimentalism.

The warmth, even the vivacity of Reynolds' more informal portraiture has been finely brought out in the Birmingham exhibition which included examples seldom or never publicly shown since his day. One had hoped, indeed, that the appealing portrait of the young Lady Elizabeth Keppel with a rose at her breast, hung not long ago in this Society's house as a memento of the master's appearance in the first British contemporary exhibition in 1760, might reappear at Birmingham in the first room devoted to his earliest career and the products of the 1750s. Many people would say that this period, during and after Reynolds' visit to Italy when he first struck up friendship with Dr. Johnson, was their favourite in the artist's production. The freshly cleaned portraits of Anne, Countess of Albemarle, and the quite unfamiliar Master John Mudge peering from behind a curtain, are both intensely studied in the pallid features and informed with a grave tenderness of realism. To this period belongs also the beautifully assured triangular design of the young Lord Milsington with his dog, reproduced here. A previously 'lost' picture, the Milsington portrait was done in the late autumn of 1759, when Reynolds had already begun work on his celebrated Althorp group of Georgiana, Countess Spencer, and her daughter, likewise balanced by a dog to form a pyramidal composition. This also exemplifies Reynolds' ability to convey the breeding of his sitter by the unaffected grace of a pose, without any such strenuous attitudinizing as marks his later efforts when the phantom of the 'grand style' floated before his eyes.

Birmingham was not concerned to disguise his defects. It reminded us indeed how often the first President, in his most imposing manner, will betray the insecurity of his grasp of form and of design in depth; how his excess of zeal in reproducing,

Lord Milsington (1759), *a previously unexhibited portrait by Reynolds, lent by Mrs. C. J. Conway to the Birmingham Exhibition*

let us say, an arrangement of several hands observed in some Seicento masterpiece or wherever else, can be so utterly distracting that the principal features of his assembly picture are only noticed afterwards. No doubt his diaries crammed with sitters' appointments, his deferred resolutions and use of a team of assistants explain much. His high-minded ambition to place British art in the great European tradition explains more. Yet he could generally recover himself in the significant composition of his single figures. 'My Lord, I do not desire all this ceremony', Dr. Johnson once corrected a complimenting nobleman; 'let us talk our minds to one another quietly.' Just so, in the least ceremonious of his thinking likenesses, does Reynolds quietly speak his own mind.

Very similarly, the current exhibition of Sir Edwin Landseer's art at the Royal Academy is an invitation to reassess the work of a leading Academician and Court favourite who is remembered chiefly for his later output, not nearly enough for the vitality of many of his smaller studies. Landseer's astonishing precocity is familiar to Fellows who know his drawing of a dog made at a very tender age, which our Society honoured and has possessed ever since. It follows that Landseer (who was born in 1802, only ten years after the death of Reynolds) came to maturity remarkably quickly; and endowed with presence and manners as ingratiating as his technical facility, he had as early as 1823 painted Georgiana, wife of the sixth Duke of Bedford.

He was then twenty-one, she forty-two, but despite their disparity of age there is a belief that after the Duke died in 1839 Landseer proposed to the Duchess and was refused. Knowledge of this relationship is essential to an understanding of Landseer's subsequent career, for there ensued the first signs of his mental breakdown and uncertain health for the rest of his life, which may partly account for the grotesque humanization of his more popular dog pictures. Yet the sureness of his hand and eye, combined with his profound knowledge of animal anatomy, rarely deserted Landseer until his final pathetic collapse after 1869.

Mr. John Woodward might have drawn on W. P. Frith's recollections to fill out his short factual introduction. 'I have often heard Edwin say', noted his fellow Academician, 'that he owed no little of his success to Haydon's insisting upon dissection of animals as a vital element in the practice of an animal painter, just as he maintained that a thorough knowledge of the human form could not be acquired without the information that dissection only could give.' The exhibition includes a series of Landseer's early studies of flayed animals, made in red and black chalk, almost as exhaustive as Stubbs's research into the anatomy of a horse. Such science gives authority to *Shoeing the Bay Mare*, lent by the Tate, the most solid and completely satisfying of the big finished compositions here.

While there is much of historic interest here, as well as the expected spirited compositions in emulation of Rubens or Delacroix, the most bracing aspect of the exhibition is the large number of fluent sketches in oils and small landscapes on which the attention of the present generation will most surely turn. An early painting of swans on a lake possesses a freshness of touch and chanciness of atmosphere which come close to Constable. The prevailing olive brown and green of these studies do not declare a very original colourist, it is true; yet the wonderfully light and vigorous touch is continually enlivening. Together with a series of delicately patterned birds, and sprightly drawings far removed from his more laborious whimsicality in oils, this exhibition of Landseer's work (the first since 1874) may well modify the popular image of the artist as the Monarch of the Glen.

Of the hundred and eighteen masterpieces from the Thyssen-Bornemisza collection, lent at the invitation of the National Gallery Trustees from their home on the shores of Lake Lugano, there is neither room nor reason to say very much. The spectacular richness of this selection from Van Eyck to Tiepolo proclaims itself, and has been properly proclaimed at length in the Press. The Italian and German schools predominate in this assemblage which sits with easy authority in an air-conditioned suite of the National Gallery. The great Venetians and the El Grecos look particularly splendid against the new green tapestry of Room 24. Among the smaller, more precious panels is a *Virgin and Child enthroned with Angels* by Fra Angelico, placed near Jan van Eyck's pair of figures representing the Virgin and Angel of the Annunciation, depicted with elaborate *trompe l'œil* effect as if they were carved in white marble. But to enumerate this selection in detail would still only account for a quarter of the foreign masterpieces on public view at the Villa Favorita, and loaned out often and selflessly by Baron Thyssen to the great museums of Europe.

NEVILE WALLIS

NATIONAL POSTER DESIGN AWARD

The Council of Industrial Design has recently announced that, in association with fifteen advertising and other organizations, it is to sponsor a series of awards—to be known as the British Poster Design Awards, 1961-2—with the object of stimulating a higher standard of design in British posters. There will be a maximum of 25 awards. Diplomas will be given to the advertiser, the advertising agency, the designer and the printer responsible for each award-winning entry. Entries will be accepted from any of these four sources. To be eligible for an award, posters must have been on display during the period from 1st April, 1961 to 31st March, 1962, and must fall within one of the following two classes: those which have been designed, produced and exhibited

in the United Kingdom, and those designed and produced in the United Kingdom but exhibited only outside.

Entries must reach the C.o.I.D. between 1st and 30th April, 1962. Full details of the competition should be obtained from Mrs. C. Mill at the Council of Industrial Design, 28 Haymarket, London, S.W.1.

EXHIBITION OF MODERN FRENCH BOOKBINDINGS

An exhibition of fine modern French bookbindings is on view in the Arts Council Gallery, 4 St. James's Square, until 22nd April. The bindings have been selected by the Société de la Reliure Originale in consultation with Mr. Howard Nixon, Deputy Keeper in the Department of Printed Books at the British Museum. The Société has also compiled the catalogue.

There are some 150 bindings in the exhibition (ranging in size from miniatures 3 in. high to 21 in. books) by eight different bookbinders. They have been chosen for the creative, personal quality of their work, which demonstrates new conceptions of decoration and new techniques and materials.

The charge for admission is 1*s.* 6*d.*, and the hours of viewing are from 10 a.m. to 6 p.m. on Mondays, Wednesdays, Fridays and Saturdays, and from 10 a.m. to 8 p.m. on Tuesdays and Thursdays.

STUDIES IN THE SOCIETY'S ARCHIVES XVIII

The Society of Arts and the Committee of the Privy Council for Trade, 1786–1815 (i)

'Lords Commissioners for promoting the trade of our Kingdom and for inspecting and improving our plantations in America and elsewhere' were appointed by William of Orange in 1696.[1] The 'Board of Trade', as the Commission came to be called, lasted until 1782, when it was abolished by Act of Parliament. Its fluctuations in power and prestige and its relationship to the 'Old Colonial System' have been studied in detail.[2] Fifteen of its Commissioners were members of the Society of Arts[3] and John Pownall, who served the Board as Secretary from 1753 until 1776,[4] was also Chairman of the Society's committee of colonies and trade. In 1763 the Earl of Hillsborough, as President of the Board, had offered to co-operate with the Society in establishing botanical gardens in the North American Colonies.[5] The Society rejected the offer and it appears to have had no further correspondence with the Board.

In 1784, because of the many commercial problems which arose out of the conclusion of the American War of Independence, a successor to the Board of Trade was established in the form of a Committee of the Privy Council for 'all matters relating to Trade and Foreign Plantations'. The Committee was reorganized in 1786 and persists to this day under the name of its predecessor.[6] Historians have paid particular attention to the work of the Committee in the decades after 1820 when it became involved in the Free Trade Movement, the development of railways, the collection of statistics and in art education.[7] Its early years are no less interesting. Its first President was Charles Jenkinson, Lord Hawkesbury, afterwards 1st Earl of Liverpool, under whom, in the words of Anna Lee Lingelbach, 'the encouragement of Trade and Commerce was pursued along traditional lines with all [his] . . . narrow-minded zeal'.[8] Hawkesbury became a member of the Society of Arts in 1789 and a Vice-President in 1791. Before he joined the Society he was already acquainted with its Secretary, Samuel More, and was familiar with its work through his office of President of the new Committee for Trade.[9] Within two months of the Committee's reorganization in 1786 a correspondence had been begun with the Society of Arts, which, though often fruitless, sometimes resulted in legislation, and which is interesting for the light it sheds on a number of contemporary commercial and industrial problems as well as for what it adds to the history of both institutions.

Charles Jenkinson, 1st Lord Hawkesbury and 1st Earl of Liverpool (from an engraving after the drawing by H. Eldridge, used as a frontispiece to Volume XXVII of the Society's Transactions)

The correspondence was sporadic. It began in November, 1786, and was maintained with fair regularity until February, 1788. In October, 1787, Samuel More, the Society's Secretary, was paid £100 by the Committee, 'Their Lordships having frequently found it necessary to desire [his] attendance . . . and to employ him in procuring information upon various subjects that have come under the consideration of the Committee'.[10] Apart from isolated exchanges in November, 1788, and February, 1789, the correspondence was not resumed until February, 1790. The years 1790 and 1791 saw a close collaboration between the two bodies, and during 1792 and 1793 there was an intermittent association. There is a complete gap between the end of October, 1793, and the middle of February, 1796, when relations were resumed for three months, and then again ceased for five years, until December, 1801, by which time Samuel More had died and been succeeded by Charles Taylor as Secretary of the Society.[11] There was no correspondence between the Society and the Committee from 1801 until 1805; 1805 and 1806 saw significant interchanges, after which there was no correspondence until 1812.[12] The correspondence came to an end in 1815. Separate consideration will now be given to the various topics which brought together the Society and the Committee.

TABLE SHOWING THE YEARS AND MONTHS DURING WHICH THERE WAS CORRESPONDENCE BETWEEN THE SOCIETY OF ARTS AND THE COMMITTEE OF THE PRIVY COUNCIL FOR TRADE, OR IN WHICH MUTUAL INVESTIGATIONS WERE CONDUCTED

1786	1791	1806
November	January	January
December	February	February
	March	April
1787	April	May
January	May	July
April		
May	1792	1812
June	January	July
October	November	August
November		
	1793	1815
1788	June	February
January	July	March
February	October	June
November		
	1796	
1789	February	
February	April	
1790	1801	
February	December	
March		
April	1805	
May	June	
June	July	
November	August	
December	September	

Hemp, 1786 *and* 1805

The first matter which brought the reformed Committee into correspondence with the Society was one which had concerned both the Society and the old Board of Trade in the days before its disestablishment. This was the cultivation of hemp.[13] On 7th November, 1786, the minutes of the Committee record that 'Mr. More, Secretary to the Society for the Encouragement of Arts, Manufactures and Commerce attended and was directed by their Lordships to collect and transmit for their Lordships' information, all the proceedings of the said Society for encouraging the growth of hemp, and generally any information he may be able to furnish on the subject of hemp'.[14] Samuel More reported the request at a Society meeting on the following day and was instructed to carry out the Committee's wishes.[15] Their Lordships received More's report on the 28th and at the same meeting[16] they sent the Society an account of an experimental examination of a sample of Chinese hemp, which the Society had sent for their consideration a fortnight before. They also decided that instructions to encourage hemp cultivation should be sent to the Governors of Canada, Nova Scotia and New Brunswick.[17] This was the beginning of a vigorous campaign by the Committee to promote the production of the fibre in North America.[18] Bounties for the importation of Canadian hemp were already allowable by Act of Parliament;[19] they were now offered for its cultivation. After 1801, as has been described in an earlier article in this series, the Society offered rewards to both cultivators and importers.[20] The Committee took advantage of the Society's

experience in 1805, when it invited Charles Taylor to write a full statement of his views on the subject. Taylor's statement was distributed in Canada by order of the Committee.[21]

Dr. Cuthbert Gordon's Dye, 1787–8

The next matter which caused the Committee of the Privy Council for Trade and Plantations to consult the Society of Arts was a new method of dyeing. It had been discovered by Dr. Cuthbert Gordon, who had already developed, in collaboration with his brother, the valuable dye known as Cudbear.[22] On 5th January, 1787, the King in Council referred to the Committee a claim of Gordon's that he had developed particularly good black and red dyes for woollen cloths and cotton which could be produced from a native moss.[23] Consultations were held throughout the spring and early summer in which Samuel More played a prominent part.[24] Eventually at a meeting of the Committee on 25th October, 1787, when 'Dr. Cuthbert Gordon, Mr. Chamberlayne Goodwin of the Dyers Company and Mr. More, Secretary of the Society for the Encouragement of Arts, Manufactures and Commerce attending were called on', it was resolved to recommend to the Treasury that £200 should be paid to Gordon and that he should have one or two acres of land and plant them with his moss. Mr. Chamberlayne Goodwin was asked to experiment with the dye on some woollen cloths and the Society was to assist in both experiments.[25]

The Society referred the matter to its committee of agriculture and chemistry, but it was unable to make a satisfactory report to the Lords of Trade because Chamberlayne Goodwin declined 'to go any further into the process of Dr. Gordon's Black Dye'.[26] Gordon proceeded with the experiments suggested by their Lordships, and he appears to have obtained a certificate in his favour from Mr. William Desanges, who was a member of the Society's committee of chemistry and who had been present at the meeting called to consider his dye. In a petition to the House of Commons, Gordon claimed that after Chamberlayne Goodwin had declined to investigate his discovery he had 'had recourse to Mr. William Desanges, nominated by the Society of Arts and Manufactures'.[27] In 1793 the House of Commons sanctioned the payment of a further £100 to Gordon, together with other sums of money to cover the expenses of his experiment.[28]

(*To be continued*)

D. G. C. A.

1. Sir H. L. Smith, *The Board of Trade* (London, 1928), p. 16.

2. Ibid., pp. 15–35; A. H. Basye, *The Lords Commissioners of Trade and Plantations . . . 1748–82* (New Haven, 1925); O. M. Dickerson, *American Colonial Government, 1696–1765: a Study of the British Board of Trade in its Relation to the American Colonies, Political, Industrial, Administrative* (Cleveland, Ohio, 1912).

3. The Earl of Dartmouth, Francis Fane, Bamber Gascoyne, Edward Gibbon, the Earl of Halifax, the Earl of Hillsborough, Soame Jenyns, William Northey, Lord Orwell, James Oswald, John Roberts, Thomas Robinson, Hans Sloane, Sir Edmund Thomas, Charles Townshend. These are names taken from the list printed in *The Journal of the Commissioners for Trade and Plantations from January, 1776 to May, 1782, preserved in the Public Record Office* (London, 1938), pp. vii–viii.

4. Sir H. L. Smith, op. cit., p. 272.

5. R.S.A., Society Minutes (hereafter Soc. Min.), 2nd and 23rd Nov., 1763; R.S.A., Committee Minutes (hereafter Min. Comm.), Miscellaneous Matters, 12th and 19th Nov., 1763. See also *Gazette du Commerce*, No. 75, 17th Dec., 1763.

6. Sir H. L. Smith, op. cit., pp. 36–46, 256.

7. See R. Prouty, *The Transformation of the Board of Trade, 1830–1855* (London, 1957); L. Brown, *The Board of Trade and the Free-Trade Movement, 1830–42* (Oxford, 1938).

8. A. L. Lingelbach, 'The Inception of the British Board of Trade': *American Historical Review*, Vol. XXX, No. 4 (1925), p. 270. For Hawkesbury's economic policy see also G. A. Cockroft, *The Public Life of George Chalmers* (New York, 1939), pp. 89–90; C. B. Fergusson, 'The Colonial Policy of the First Earl of Liverpool as President of the Committee for Trade, 1786–1804' (typescript D. Phil. thesis, Oxford, 1952), *passim*.

9. Charles Jenkinson, 1727–1808, Baron Hawkesbury (1786) and Earl of Liverpool (1796). He was elected a member of the Society on 28th Oct., 1789, and a Vice-President on 22nd March, 1791 (see Soc. Min. under these dates and *Transactions*, Vol. XXVII (1809) p. iii). A letter from More to Hawkesbury dated 16th Oct., 1789, which provides information about an engraver of dies for medals, shows that Hawkesbury consulted More about matters other than those which were of mutual interest to the Society and the Committee (B.M. Add. MSS. 38224, f. 305). When the Society's committee of agriculture decided to distribute some special grass seeds, Hawkesbury's name was not included in the list of intended recipients (Min. Comm. Agriculture, 8th Nov., 1790), but More arranged for him to be sent some (B.M. Add. MSS. 38225, f. 325, Samuel More to Lord Hawkesbury, 22nd Nov., 1790).

10. P.R.O., BT5/4, 26th Oct., 1787. The records of the Committee which are deposited in the Public Record Office are divided into the following classes: BT1 In-letters 1791– ; BT3 Out-letters 1786– ; BT5 Minutes 1784– . See *Public Record Office Lists and Indexes*, No. XLVI (London, 1921), pp. 207–10.

11. More died in 1799 and Taylor remained Secretary until his death in 1816. Taylor had also acted as consultant to the Committee in 1786 (see BT5/4, loc. cit.), and in 1791 (see BM. Add. MSS. 38226, f. 23. Letter from Taylor to George Chalmers answering inquiries about textiles to be communicated to Lord Hawkesbury 11th July, 1791).

12. The Committee addressed inquiries to Charles Taylor in 1811 and 1813 which may be regarded as semi-personal, for he did not pass them on to the Society. The first was about Madder (see BT3/11, 11th Dec., 1811) and the second about Cream of Tartar (see BT3/12, 11th May, 1813).

13. See R. Dossie, *Memoirs of Agriculture and other Economical Arts*, Vol. I (London, 1768), pp. 277–9; *Journal of the Commissioners for Trade and Plantations, from January 1768 to December, 1775, preserved in the Public Record Office* (London, 1937), pp. 82–3; Sir H. L. Smith, op. cit., p. 32.

14. BT5/4, 7th Nov., 1786. A letter had been written to More asking him to attend (BT3/1, 1st Nov., 1786), and on 1st Jan., 1787, More arranged an interview with Hawkesbury 'on a subject relating to the Flax, Hemp and Wool of this Kingdom' (B.M. Add. MSS. 38221, f. 83). On 29th Nov., 1788, Lord Hawkesbury expressed approval of the papers on hemp sent to him by the Society (R.S.A., Loose Archives A15/20. G. Chalmers, 1788) and on 7th Feb., 1789, the Committee informed Samuel More that the Treasury kept the Government papers on the hemp bounties (ibid., C1/16. S. Cottrell, 1789).

15. Soc. Min., 8th Nov., 1786.

16. BT5/4, 28th Nov., 1786.

17. BT3/1, 28th Nov., 1786; Soc. Min., 29th Nov., 1786.

18. G. S. Graham, *British Policy and Canada, 1774–1791: a Study in Eighteenth Century Trade Policy* (London, 1930), pp. 114–15. C. B. Fergusson, op. cit., pp. 77–8.

19. 26 George III, c. 53. This Act continued the Act for a bounty on the importation of hemp and undressed flax from the British Colonies in America until 24th June, 1806. It was continued by 46 George III, c. 29, until 25th March, 1808.

20. 'Colonel William Tatham, an Anglo-American Member of the Society, 1801–4': *Journal*, Vol. CVIII (1960), pp. 229–33.

21. BT5/15, 14th, 24th and 28th June, 2nd and 17th July, 24th August, 1805.

The Committee had also corresponded with the Society about hemp in 1801 (BT3/6, 28th Dec., 1801).

22. A. Clow and N. Clow, *The Chemical Revolution, a Contribution to Social Technology* (London, 1952), p. 210.

23. BT5/4, 1st Dec., 1786. The House of Commons had already investigated the matter and come to the conclusion that the Committee of the Privy Council for Trade was the appropriate body to investigate Gordon's claims (*Journals of the House of Commons*, Vol. XLI, p. 963). On 5th Sept., 1786, James Macpherson, M.P., wrote to Lord Hawkesbury in favour of Gordon's discoveries (B.M. Add. MSS. 38220, f. 8).

24. BT5/4, 18th April, 1st May and 13th June, 1787.

25. Ibid., 25th Oct., 1787.

26. Soc. Min., 4th Nov., 1787, and 23rd Jan., 1788; Min. Comm., Chemistry, 20th Nov., 1787; BT5/5, 9th Feb., 1788.

27. *J. H. C.*, Vol. XLVI, p. 241.

28. Ibid., Vol. XLVII, p. 292.

OBITUARY

We record with regret the death of the following four Fellows of the Society.

GENERAL SIR KENNETH CRAWFORD

General Sir Kenneth Noel Crawford, K.C.B., M.C., Deputy Chief of the Imperial General Staff from 1947 to 1949, and Chief Royal Engineer since 1958, died on 5th March, aged 65. As a young officer in the Engineers he served with distinction in the First World War, and during the Second held several key appointments. In 1940-41 he was successively Commandant of the Army Gas School, Inspector of Chemical Warfare, and Brigadier, General Staff, Northern Ireland. From 1942-6 he was Director, Air (including Airborne Forces) at the War Office. In 1946 he was appointed to be G.O.C., Land Forces, Greece, and the following year, as Deputy C.I.G.S., became responsible for scientific research and weapon development in the Army. From 1949 to 1953 he was Controller of Supplies (Munitions) at the Ministry of Supply. In this capacity he presided at a meeting of the Society in October, 1953, when Mr. O. H. (now Sir Owen) Wansbrough-Jones delivered the Pope Memorial Lecture on 'The Scientist's Place in the Services' (*Journal*, Vol. CI, p. 854).

Crawford retired in 1953 and subsequently joined the boards of a number of industrial undertakings. He was Chairman of Edwin Danks (Oldbury) Ltd., and a Director of Cyanamid of Great Britain Ltd., and of Westland Aircraft Ltd. He was elected a Fellow of this Society in 1954.

SIR CHARLES REID

Sir Charles Carlow Reid, who as an engineer and administrator played a notable part in the development of the coal-mining industry, died at Eastbourne on 19th February, aged 82. He was born and educated in Scotland. While still a youth he went to work down the pit, but was soon marked out for managerial responsibility, first at Aitken Colliery, Fife, and then at the Donibristle Colliery. In 1923 he became General Manager of the Fife Coal Company's workings, and in 1931 a Director of the Company. He held these posts until 1942, when he joined the Ministry of Fuel and Power as Regional Production Director for Scotland. In 1943 he was made Director of Coal Production for Great Britain.

Reid was Chairman of the Government-sponsored Technical Advisory Committee on Coal Mining in 1944-45. The strong recommendations made by this Committee bore the impress of Reid's great practical knowledge of the industry and his concern for its efficiency. The Reid Report, as it came to be known, was described by Lord

Balfour as 'the bible of technical development' in this field. When Sir Charles Reid (he had been knighted in 1945) became one of the original members of the National Coal Board a year later, the appointment was generally welcomed as a most appropriate one. He resigned it in 1948, however, expressing his lack of confidence, not in state ownership itself—of which principle he had been an advocate—but in the system of organization which the Board had set up.

In March, 1949, Reid and his son, Dr. William Reid, were jointly responsible for the Cadman Memorial Lecture delivered to the Society on 'The Reconstruction of the Mining Industry' (*Journal*, Vol. XCVII, p. 461). Sir Charles was elected a Fellow in the following year.

MR. NUNZIO VAYANA

Mr. Nunzio Vayana, who died recently at Olgonquin, Maine, aged 73, was the founder and director of the Olgonquin Art Centre and had for forty years presided over its annual art exhibitions. Himself a gifted painter, particularly of marine pieces and landscapes, he will be remembered also for the encouragement he gave to young painters, whose works he welcomed in the annual shows together with those by established artists. Mr. Vayana was born in Italy and emigrated to the United States as a young man. He lived for many years at Hartford, Connecticut, where he came to know the most famous resident of that town, Mark Twain. After the author's death, Vayana took a leading part in launching the scheme whereby Twain's House in Hartford was preserved as a museum.

Mr. Vayana was elected a Fellow of the Society in 1959.

MR. HAROLD WRIGHT

Mr. Harold James Lean Wright, who died on 28th February, aged 75, was a connoisseur of old and modern prints whose judgement was widely respected. He had been a member of the firm of P. & D. Colnaghi Ltd., for 50 years, and a Director since 1939. He published a number of valuable contributions to scholarship in his field, including an enlarged translation of Delteil's Catalogue of the etchings of the nineteenth-century artist, Charles Meryon, and catalogues of the etchings of F. L. Griggs and Sir William Russell Flint. He delivered to this Society a series of Cantor lectures on 'Three Master Etchers: Rembrandt, Meryon, Whistler' (*Journal*, Vol. LXXVIII, p. 1059) in 1930, and in 1939 a further series on 'Some Masters of Engraving' (*Journal*, Vol. LXXXVII, p. 1059), in which he showed his remarkable knowledge of Italian, German, Dutch and French work from the fifteenth to the seventeenth century. He was elected a Fellow of the Society in 1954.

CORRESPONDENCE

THE DEVELOPMENT OF THE AEROPLANE

From *Mr. Oswald Short, Gillhams Farm, Lynchmere, Haslemere, Surrey*

In your *Journal* for January, 1959, there is a lecture ['The Development of the Aeroplane'] by Peter W. Brooks, Technical Assistant to the Chairman, British European Airways. On page 107, the lecturer says, 'The Rohrbach and Short design techniques were adopted, improved and combined in aircraft . . . by American aircraft designers, in the late 1920s and early 1930s', and later, 'The stressed-skin metal monoplanes produced by the Americans in the 1930s marked the beginning of the type of . . . aircraft . . . which was to be built in very large numbers during the Second World War'.

Actually the first stressed-skin biplane aircraft (aeroplane), the 'Silver Streak', was exhibited by me at Olympia on 12th July, 1920, and a patent was granted to me

in 1921 after the usual search for anticipation. An article appeared about this machine in *The Engineer*, 16th July, 1920.

Before building the 'Silver Streak', I began experiments on 'Duralumin' ribs in 1918. In September, 1919, I proved by hydraulic test that a section of the fuselage would withstand an internal pressure of 7 lb. per square inch. Now the latter-day 'Comets' flying at 40,000 ft. altitude have an internal air pressure of 8 lb. per square inch to enable the passengers to breathe. Rohrbach may have made the all-metal wing, made of 'Duralumin'. This was not carried out by Short Brothers until the Empire flying boat was produced in 1936, when that machine was flying. The monocoque fuselage, *made of 'Duralumin'*, was therefore made by me. The term 'smooth skin' means nothing as regards strength in fuselages or wings. The metal must be of a certain thickness or gauge. A smooth metal surface means nothing in the way of strength. It might be 1000th of an inch thick. Mr. Peter Brook's lecture is generally fair, but in some parts he has been misinformed, I think.

NOTES ON BOOKS

SYMBOLS, SIGNS AND THEIR MEANING. *By Arnold Whittick. London, Leonard Hill, 1960. 50s net*

Symbolism, one of the most profound of themes, has attracted to itself very little in the way of specific literature, though it forms, of course, an important element in every serious treatise on philosophy, art and psychology. It is incidentally, from the study of one or another of these, that such knowledge as most of us possess of the use and import of symbols has been largely derived. Mr. Whittick's object here is to concentrate our attention upon symbolism itself, and more particularly on visual symbols—their origins, development and present application. The significance of such an undertaking to all who are creatively engaged in any of the visual arts, and to the many more who are intelligently interested in them, will be immediately apparent.

So vast, so universal and immemorial is the subject that the dearth of literature exclusively devoted to it is hardly surprising. The fact that Mr. Whittick has succeeded in reducing this intractable material to manageable proportions from the reader's point of view, and that he presents it in a form that delights the eye as it instructs the mind, renders this book a landmark in the field of aesthetic studies. The volume itself is an invitation to the reader's interest. Admirably bound and printed, it contains a wealth of illustrations, garnered from a wide range of periods and cultures, that brings the subject to life with remarkable immediacy.

Our assimilation of the material is greatly facilitated by the partitioning of the work. Part I is a most intelligible introduction to the meaning and types of symbolism. Part II is devoted to its more precise and practical applications, exemplified in chapters on Totems, Standards and Flags; Coats of Arms; Military Badges; Seals; Civic Heraldry; Coins; Medals; Trade Marks; Shop and Inn Signs; Pictorial Advertising. Part III is an encyclopaedic dictionary of traditional and familiar symbols, while Part IV treats of symbolism from the instinctive, creative and imaginative angles—Unconscious Symbolism; Religious Symbolism; National and State Symbolism; Symbolism in Art; The Dance; Dress; Architecture; Sculpture; Painting; Drama. Bibliography and index are all that could be desired.

Part III—the Dictionary of Symbols—calls for especial mention. Occupying nearly half the total space it is, in fact, the core of the work, and could indeed stand as a volume in its own right. It represents the most ambitious project of its kind yet attempted. Here, brought together for the first time, lucidly explained and copiously illustrated, is a vast collection of visual symbols, many of them unfamiliar. Origins are given, where known or deducible, and typical uses of each symbol, both in art and literature, are recorded. As, moreover, the intention of the book is practical, the

author, wherever possible, concludes with suggestions for present applications. Under *Amaranth* he writes, for example:

> By a fanciful association of its meanings it might be regarded as typifying immortal love, a meaning that would make it appropriate as a decoration for ecclesiastical furnishings. The amaranth is a fresh and interesting subject for the designer, for the long pendent-like forms of some species and the shape of the everlasting flower could effectively be utilised.

In the interpretative essays that form the last part of the work the scope for disagreement inevitably increases. I cannot, for example, accept all the constructions that Mr. Whittick places on unconscious symbolism or on the significance of dress. I am at variance with him most, however, over some of his interpretations of Christian doctrine, which occasionally seem to me gratuitously controversial. The chapters on symbolism in architecture, painting and sculpture, on the other hand—so beautifully and intelligently illustrated—represent aesthetic appraisal and analysis of the highest order. Throughout the book, indeed, the illustrations have been so appositely chosen as to suggest that they were present to the author's mind as he wrote his text. Mr. Whittick's prose is of a quality that makes it fit company for the best of them—a classical, timeless prose which I feel to be appropriate; for here, surely, is a book that bears all the marks of becoming a standard work.

WILFRED SALTER

THE ARTIST AND HIS WORLD: *A Young Person's Guide. By Julian Trevelyan. London, Gollancz*, 1960. 12*s* 6*d net*

PREPARATION FOR PAINTING: *The Purpose and the Materials of the Artist. By Lynton Lamb. Harmondsworth, Penguin Books*, 1960. 3*s* 6*d net*

THE CRAFTSMAN'S HANDBOOK—'IL LIBRO DELL' ARTE'. *By Cennino d'Andrea Cennini. Translated by Daniel V. Thompson, Jr. New York, Dover Publications Inc.*, 1960. $1.25

The first of these three books, *The Artist and His World*, is amusing and readable. In it we find an interesting account of existing art schools in this country and abroad. The chapters on dealers and critics are instructive and entertaining, and will doubtless 'ring a bell' in the minds of all those who can recall the sensation of setting out with a portfolio under their arm in hopes of being discovered by some tycoon of the Art World! Whether 'the young person' to whom this book is addressed will find guidance of a practical nature in its pages is another matter.

Mr. Lynton Lamb's little book, on the other hand, should be helpful to beginners in many respects. In his chapters dealing with materials, equipment, etc., the author gives much information essential to the training of an artist, although experienced painters may not all be able to agree with some of the materials recommended. Interesting quotations from various writers on art are scattered throughout the book and the illustrations provide an added attraction to a well-produced volume.

The third book under review is of a more serious nature, falling indeed into an altogether different category.

This new edition of Professor Daniel V. Thompson's translation of the famous fifteenth-century treatise by Cennino Cennini is happily one which is likely to be within the means of every art student. We could have wished for a more inviting and decorative cover design, the present one being almost more suggestive of a manual on palmistry than of a great treatise on painting! Otherwise the book is well got up and the type admirably clear.

In their note on the back, the publishers appear to be over-modest in their suggestion that the appeal of this book will be mainly one of naïveté and quaintness, or that it will be merely of antiquarian interest, for the translator in his preface makes it clear that he has in mind 'the convenience of the practising student and painter', and 'that every effort has been made to translate Cennini's materials and methods into the resources of modern commerce and the idiom of modern craftsmen'. We suggest,

therefore, that the publishers, by bringing out this new, paper-backed edition of Thompson's most scholarly work, are doing an even greater service to the cause of art than they realize. For surely, if there is to be any serious re-birth of art in this century, it might well spring from an enthusiastic and intensive study of such methods of craftsmanship as we find described in the pages of Cennini's *Trattato*.

The book will be of interest to readers of varying occupations and outlooks. It will afford the art historian new light on many details of the day-to-day happenings in the *botteghe* of the painters of Florence during the fourteenth and fifteenth centuries. It will fascinate the connoisseur and stimulate the critic, assisting them both in their study of the painter's art in medieval times. It will prove of practical value to the present day painter and will enable the artist-restorer (so often groping in a tentative way after a lost tradition) to approach his work with confidence—for it is only by an intimate knowledge of the methods and materials used by the Masters that the highly specialized task of restoration can be accomplished with any measure of safety or success.

Professor Thompson's work appears to be the most accurate and, although first published in 1932, still the most up-to-date English translation. In it he has been able to clear up several points left in doubt by previous translators, and this by means of much scholarly research and by a close comparative study of the *Trattato* with other early writings on art, notably the Marciana MS. and the *Illuminierbuch* of Boltz von Ruffach. Certain small *lacunae* and language difficulties there will always be in Cennini's treatise, unless indeed another early Italian text should be discovered supplying these deficiencies, but Professor Thompson has made a signal contribution to a thorough understanding of the practice of painting in medieval times. As is the case with all translations, it is important that the writer, as well as being thoroughly conversant with the language he is translating should at the same time have an intimate knowledge of the subject in hand, and happily Professor Thompson is himself versed in the actual processes he discusses, having taught and practised them for many years. Written in a breezy style, the present translation is eminently readable, although here and there an occasional 'Americanism' makes it more difficult for the English reader to grasp than for our friends across the Atlantic, but having once accustomed ourselves to such terms as, for instance, 'step up' for 'gradate', 'straight color' for 'pure colour' and 'sound out' for 'test', we can appreciate the whole as a masterly example of clarity in translation.

There is a growing feeling to-day that a return to a greater interest in and knowledge of his materials on the part of the artist is long overdue. Be that as it may, it is greatly to be hoped that the re-appearance of this translation of a great medieval guide to 'the whole art of painting' may encourage the artist of to-day to build his work, not on the quicksand of every passing fashion but on the rock of a great tradition.

ROSAMUND BORRADAILE

DISCOVERING MEDIEVAL ART. *By G. M. Durant. London, Bell,* 1960. 21*s net*

This is emphatically not a book for scholars. The authoress expresses herself with really rather embarrassing enthusiasm and she makes use of a tiresome gimmick in regularly saying 'I find' this, that or the other, when what she means is that she has read it in Weizmann or whoever it may be (there are no references) and agrees. When she deserts her authorities she is liable to miss the point; for instance she describes the twenty-odd nearly identical portrayals of Henry of Mamesfield in the windows of Merton College Chapel, all clearly labelled, as 'little monkish or bishops' figures'. It serves him right for being so greedy for the prayers and admiration of posterity; but still she makes great play in her introduction with the (highly questionable) thesis that the mentality of medieval man was fundamentally different from our own, and has nevertheless here failed to notice a particularly striking piece of evidence in her own support. The work indeed shows signs of haste. 'It is not only,

however, in Italy but in Greece and the Balkans' she writes, 'that I find wall painting influenced by Byzantinism'. Although a remark like this does provide quiet entertainment, anyone wishing his book to be taken seriously would presumably notice it and drop it, if he read through what he had written a second time.

But still, this kind of criticism is not entirely fair. Most of those of us who are interested in the arts can remember, with a combination of nostalgia and embarrassment, a time in our lives when we too were enthusiastic in this sort of way, and were equally liable to miss the point and utter what we now know were absurd pontifications. Most of the book is perfectly sound; it represents what one would expect an intelligent person to know if—let us guess—he normally spent his holidays sightseeing in England, occasionally went to France, had been on a couple of Hellenic Cruises, and had made a fairly determined effort to organize and correlate his impressions. Whether this kind of book comes across depends almost entirely on whether the reader has the kind of mind which is naturally attuned to the writer's; and in this particular case I suspect that the reader most likely to benefit will be rather young. It cannot possibly do any harm, and if anyone has a rather studious goddaughter whose studies do not bear directly on the Middle Ages, it would make a very suitable present. Parts of it will probably be difficult to follow for anyone who does not already know the material, as the illustrations are, rather inevitably, quite insufficient. But then, if the goddaughter is interested, she will go to the local public library and get out some book with more and better pictures; and if she does, this book will have fulfilled the function it was intended to perform.

CHRISTOPHER HOHLER

GUIDE TO THE STARS. *By Patrick Moore. London, Eyre and Spottiswoode,* 1960. 21*s net*

Unlike many of the sciences, nearly everyone takes an interest in astronomy at some time or another. Astronomical books, however, are either too popular to be accurate, or written by experts for experts, with the astronomer appearing to shelter behind a jargon of Greek names and units such as the parsec. This book is a happy mean between these two extremes. Of course, the Greek names for the stars are used, but not without proper introduction, in a ten-page chapter, with reference to rival nomenclatures on page 32, while on page 45 we find a neat table expressing Astronomical Units, light years and parsecs in terms of one another, and of the familiar mile.

This is definitely a book on astronomy written for those who are expert in another of the sciences. Definitions are built up gradually, until the vocabulary of astronomical terms is complete. In the process the author manages to retain much of the basic enthusiasm of the amateur astronomer. The sky is seen as a whole, and its changing face with the Seasons, and with the latitude of the observer being discussed in Chapters 5 and 6.

We then see the relationship between our sun and the life cycle of typical stars, together with a discussion of those stars which do not appear to be in the 'main stream'. This is followed by a chapter on double stars, showing how our knowledge has benefited from their study, in particular the proof of the high density of the white dwarf companions of stars such as Sirius, and their low emission of energy.

Spectroscopic binaries are also treated in some detail. Variable stars not only include the Cepheid variables, but other less regular variables of interest, and this is followed by temporary stars, with due distinction being drawn between novae and supernovae. Star clusters such as the Pleiades and Hyades are discussed in some detail but the chapter on Nebulae is perhaps a little brief.

The description of galaxies is then followed by a chapter on radio telescopes, linking these observations with supernovae. The last chapter deals with the various theories seeking to explain the expanding Universe, while emphasizing that the

evidence for expansion is entirely based on reddening of the light received from the most distant galaxies. Various theories of the birth and evolution of the Universe are discussed, as well as the Cambridge school of thought that 'the Universe has always been, and will always be, in much the same state as it is now'.

Finally we have a useful set of 7 appendices tabulating bright or interesting stars, constellations, etc.

This book is highly recommended to intelligent beginners in astronomy, while the more advanced will be stimulated by its bright and easy style, which is not of the 'popular' type. It is very far removed from the standard textbook suitable for serious astronomers.

W. F. HILTON

LIBRARY ADDITIONS

Fellows and Associates are reminded that they may borrow up to five books at a time from the Library and retain them for a month. Members living outside London may borrow books by post. Books sent by post are despatched at the cost of the Society and returned at the cost of the borrower. Books marked with an asterisk are part of the reference library, and not normally available for loan.

LIBRARIES, MUSEUMS AND SOCIETIES

*BLUHM, R. K.—A guide to the archives of the Royal Society and to the other manuscripts in its possession. *Reprinted from Notes and Records of the Royal Society*, Vol. 12, No. 1, August, 1956. Presented by the Royal Society

*HEWITT, ARTHUR REGINALD—Guide to resources for Commonwealth studies in London, Oxford and Cambridge; with bibliographical and other information. *London, published for the Institute of Commonwealth Studies by Athlone Press*, 1957.

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*JOCELYN, ARTHUR—Awards of honour: the orders, decorations, medals and awards of Great Britain and the Commonwealth from Edward III to Elizabeth II; with a foreword by the Rt. Honble. the Earl Mountbatten of Burma. *London, Black*, 1956.

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*DENNEHY, WILLIAM F. (*editor*)—Record, the Irish international exhibition, 1907. *Dublin, Hely*, 1909.

ROBIN, CHARLES—Histoire illustrée de l'exposition universelle par catégories d'industries avec notices sur les exposantes. Première partie. *Paris, Furne*, 1855.

ARCHITECTURE AND BUILDING

ADDLESHAW, G. W. O. *and* ETCHELLS, F.—The architectural setting of anglican worship; an inquiry into the arrangements for public worship in the Church of England from the reformation to the present day. *London, Faber*, 1948.

ANSON, PETER FREDERICK—Fashions in church furnishings, 1840-1940. *London, Faith Press*, 1960.

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[and] with commentaries on the illustrations by Helmut Domke. *London, Batsford*, 1960.

DAVIS, TERENCE—The architecture of John Nash; introduced with a critical essay by Sir John Summerson. *London, Studio*, 1960.

*HUSSEY, CHRISTOPHER—English country houses: mid-Georgian, 1760-1800. *London, Country Life*, 1956.

THE WORKS OF PIER LUIGI NERVI—preface by Pier Luigi Nervi; introduction by Ernesto N. Rogers; explanatory notes to illustrations by Jürgen Joedicke; translation by Ernest Priefert. *London, Architectural Press*, 1957.

FROM THE JOURNAL OF 1861

VOLUME IX. *26th April*

THE SHIPWRECK KITE

SIR,—In the 41st volume of the transactions of the Society of Arts, page 182, will be found a full description of Captain C. C. Dansey's, R.A., kite, as adapted to the saving of lives of shipwrecked mariners. The invention was fully carried out, and a large-sized kite was deposited in the Society's rooms, and was tried by myself and others in Hyde Park, in 1824. The kite was eighteen feet high, and formed of such materials as are always found in abundance in every ship, that is, boat sails, spars, and cordage. The kite line was held fast to the belly-band by means of a toggle, which, when struck out by a messenger sent up the main line, discharged the belly-band and caused the kite to fall flat on the land or cliff, still held fast by the main line. The upright spar, or backbone, carried on its head four small anchor flukes reversed, by means of which, if there were no persons on shore, a hardy seaman might haul himself to land through the breakers.

The eighteen-feet kite, presented to the Society by Captain C. C. Dansey, would require about eighteen men to hold it in a strong gale, and is therefore fully capable of towing on shore any sized empty cask, carrying a small hawser attached, so as to secure communication from the wreck to the shore, even in the case of there being no landmen to assist, a situation almost impossible on the British coast.

Not long after the publication and public exhibition of Captain C. C. Dansey's Shipwreck Kite, the same invention was applied to the purpose of drawing carriages on the common roads, which often performed at the rate of twenty miles an hour, with two riders. In this case, in order to obviate as much as possible the difficulty of adverse winds, Mr. Purkis added two guy lines, made fast to each wing of the kite respectively, and conducted by fair leaders along the main line. By tightening either guy, the kite could be close hauled upon a wind and, with the assistance of the steering wheels, the carriage was drawn in any direction, provided the wind was not before the beam.

The application was, of course, merely an amusing development of a boy's common kite, and could not be brought into general use, on account of the unsteady and variable nature of the moving power, as well as on account of the terror excited among the horses on the roads. Railways were then unknown.

But this power may be applied with great advantage in boat-sailing, as a kite exerts much more power than an equal spread of canvas as a sail. This mode of traction may, however, be applied in two cases of land locomotion—on the ice and hard snow in the northern parts of Europe and America, as well as furnishing the means of travelling over the sandy deserts of Africa. . . .

It will be seen that in the case of shipwrecks, which always take place on a lee shore,

Dansey's kite, as improved with Purkis's guy lines, has this advantage—that it may be directed from the ship to fall on that part of the coast most favourable for a safe landing, and that such a kite, with its three lines, is as perfectly under control as a pair of well-trained horses.

I have been impelled to make this communication through having seen a report of the reward of fifty guineas being given to Lieutenant G. S. Nares for his invention of a kite intended for the use of shipwrecked mariners not, however, with the slightest intention of depreciating that gentleman's inventive powers, or his humane endeavours. . . . But I do not think it right that Captain Dansey's claims for the same invention, published so many years ago in the Society's Transactions, should be wholly lost sight of by the Shipwrecked Fishermen's Society, upon whom Lieutenant Nares has so nobly bestowed the reward conferred upon him for his invention.

A detailed report of Lieutenant Nare's experiments may be seen in *The Practical Mechanics'* Journal for March, 1861, page 327.

I am, &c.,

HENRY W. REVELEY

Some Activities of Other Societies and Organizations

MEETINGS

THURS. 6 APR. Analytical Chemistry, Society for, at 'The Feathers', Tudor Street, E.C.4. 6.30 p.m. Discussion : *Principles involved in collaborative studies.*

Radio Engineers, British Institution of, at London School of Hygiene & Tropical Medicine, Keppel Street, W.C.1. 6 p.m. Discussion : *Transistorized television receivers.*

Refrigeration, Institute of, at Institute of Marine Engineers, 76 Mark Lane, E.C.3. 5.30 p.m. J. A. Cox : *Results of practical experiments on relative humidity control.*

MON. 10 APR. Engineers, Society of, at Geological Society Burlington House, W. 5 p.m. A. E. Canham : *The use of electric light and heat in horticulture.*

Royal Geographical Society, 1 Kensington Gore, S.W.7. 8.30 p.m. H. W. Tilman : *Voyage to Iles Crozet and Kerguelen.*

WED. 12 APR. Radio Engineers, British Institution of, at London School of Hygiene & Tropical Medicine, Keppel Street, W.C.1. 6 p.m. D. E. Mullinger : *Vibration analysis and testing.*

THURS. 13 APR. Civil Engineers, Institution of, Great George Street, S.W.1. 5.30 p.m. H.R.H. the Duke of Edinburgh : *Resources, human and material, of the Commonwealth.*

MON. 17 APR. Royal Geographical Society, 1 Kensington Gore, S.W.7. 6 p.m. Film : *Festival in Kano.*

WED. 19 APR. Radio Engineers, British Institution of, at University College Medical School, Gower Street, W.C.1. 6 p.m. Dr. C. N. Smyth : *Instrumentation for obstetrics.*

THURS. 20 APR. Civil Engineers, Institution of, Great George Street, S.W.1. 5.30 p.m. Discussion : *Traffic planning and design of roads in Cumbernauld New Town.*

Mining and Metallurgy, Institution of, at Geological Society, Burlington House, W.1. 5 p.m. T. Yonezawa : *Experimental study of absorption and desorption of Xanthate by Sphalerite* ; A. W. Fletcher and J. C. Wilson : *Naphthenic acid as a liquid-liquid extraction reagent for metals.*

MON. 24 APR. Royal Geographical Society, 1 Kensington Gore, S.W.7. 5 p.m. Professor J. A. Steers : *Coastal cliffs.*

TUES. 25 APR. Civil Engineers, Institution of, Great George Street, S.W.1. 5.30 p.m. Sir Herbert Manzoni : *The inner ring road, Birmingham.*

WED. 26 APR. Radio Engineers, British Institution of, at London School of Hygiene & Tropical Medicine, Keppel Street, W.C.1. 6 p.m. Symposium : *Electronic counting techniques.*

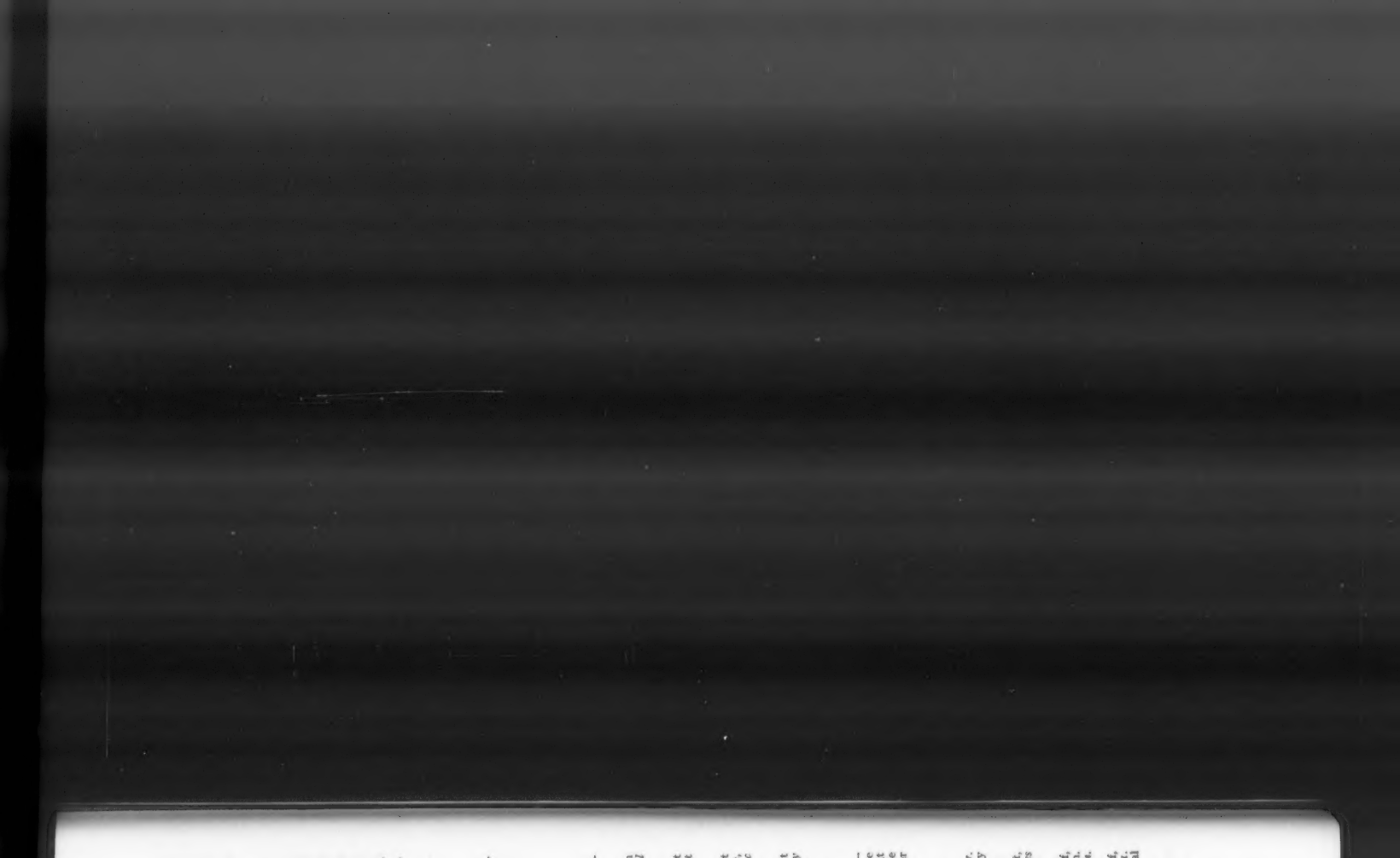
THURS. 27 APR. Civil Engineers, Institution of, Great George Street, S.W.1. 5.30 p.m. Discussion : *Safety aspects of motorway design.*

Architectural Historians of Great Britain, Society of—ANNUAL CONFERENCE : At the executive committee meeting held in York on 10th March, it was decided to hold the Annual Conference of the Society at Edinburgh from 15th–17th September next.

OTHER ACTIVITIES

NOW UNTIL 4 APR. Commonwealth Institute, S.W.7. Exhibition : *The Canadian Indian.* Paintings by Mildred Valley Thornton.

NOW UNTIL SAT. 8 APR. Building Centre, 26 Store Street, W.C.1. 9.30 a.m. Exhibition : *Materials and finishes in modern hospital building.*

FRI. 7 APR.–SAT. 6 MAY. Industrial Design, Council of, at Griffin & Spalding, Long Row, Nottingham. Exhibition : *The Design Centre comes to Nottingham.*

MON. 24 APR.–SAT. 13 MAY. Industrial Design, Council of, The Design Centre, 28 Haymarket, S.W.1. Exhibition : *Designs for a decade* 1951–61. A Festival of Britain anniversary display.